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Established Over 31 Years

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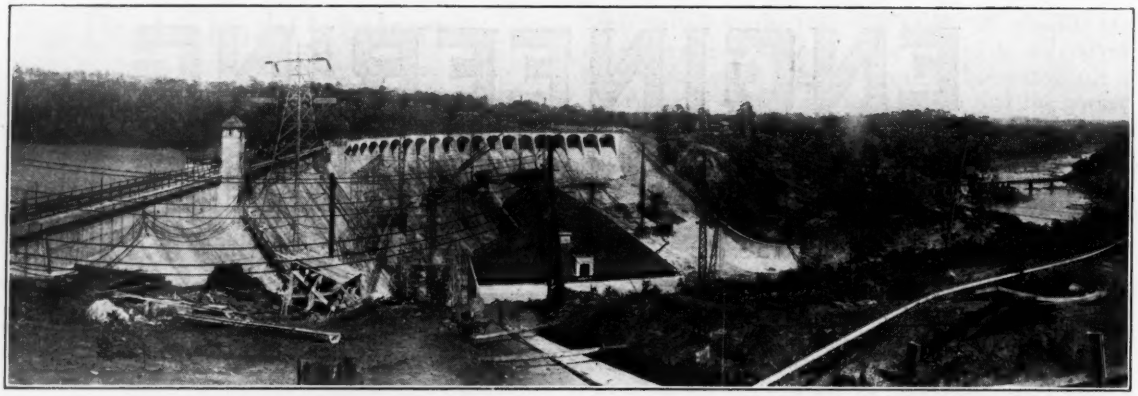
A Maid in Distress

HELP! HELP! A maiden in distress! Help! Picture the brave knights of old rallying at this cry. How they would have rushed for their lances and cast iron overcoats and clattered away on their steeds to her rescue! How, indeed!

But, alas, all King Arthur's knights would have been powerless to help this maid, for it is not a dragon, nor a cruel giant, nor a sorcerer she is beset with, but commutator trouble. And commutator trouble is far more formidable to a knight than all the dragons and giants and sorcerers of old put together. Imagine the invincible Sir Lancelot rushing in and sticking his spear into the snappy end of a 600-v. generator. Imagine his consternation when this docile object spat molten copper back at him—the scene is too sad to contemplate.

But, to get back to our maiden. Why is this wistful young lady so concerned about a commutator? What can a mere commutator matter in her young life? Matter enough! This young lady owns this generator and when it is out of commission the lights in her Studio are out. She is one of Hollywood's famous movie stars and is shown here in the power plant at her studio. But, really, to be perfectly frank, we don't know whether it is a burnt commutator that makes her look so sad or not; perhaps it is due to an *affaire d'amour* and she has come into the power plant to seek solace in the contemplation of engineering wonders.

At any rate, electric power, particularly for lighting, is important in the moving picture industry and while nothing further is mentioned about this young lady, there is an article on the subject on page 309.



Martin Dam Aids Control of Alabama System

New Hydro Plant of Alabama Power Co. on Tallapoosa River, with Initial Installation of 135,000 Hp. Forms Storage Project to Aid Steam and Run-of-River Plants During Low Water. By F. E. Hale* and R. R. Stone†

AT CHEROKEE BLUFFS, on the Tallapoosa River, about 42 mi. northeast of Montgomery, Alabama, the Alabama Power Co. has just completed the construction of the Martin Dam project. This development is a storage project, as distinguished from the run-of-river plants which the company has already built at Lock 12 and Mitchell Dam on the Coosa River, and the Lock 18 development now under construction. After exhaustive studies of load conditions in territory served by the company, and taking into consideration all steam reserve and hydro plants on the system, it was shown that this storage plant will best meet the demand for power during the low water seasons. Martin Dam developed for a maximum head of 150 ft., creates one of the largest artificial reservoirs in the world, storing about 71,000,000,000 cu. ft. of water, 60,000,000,000 cu. ft. of which are available for power purposes in the upper 60 ft. of the reservoir. The impounded lake covers nearly 40,000 acres with a shore line of 700 mi. The available storage under normal operating conditions will provide a regulated river flow of 3260 cu. ft. a second if operated as an independent plant. The low water flow of the Tallapoosa River at this point is as low as 500 sec.-ft. This storage will materially aid navigation conditions in the Alabama River, the larger river into which the Tallapoosa flows. The initial installation consists of three 45,000-hp. units, with provision for a fourth unit.

*Assistant Designing Engineer, Alabama Power Co.
†Engineer in Charge of Electrical Design, Alabama Power Co.

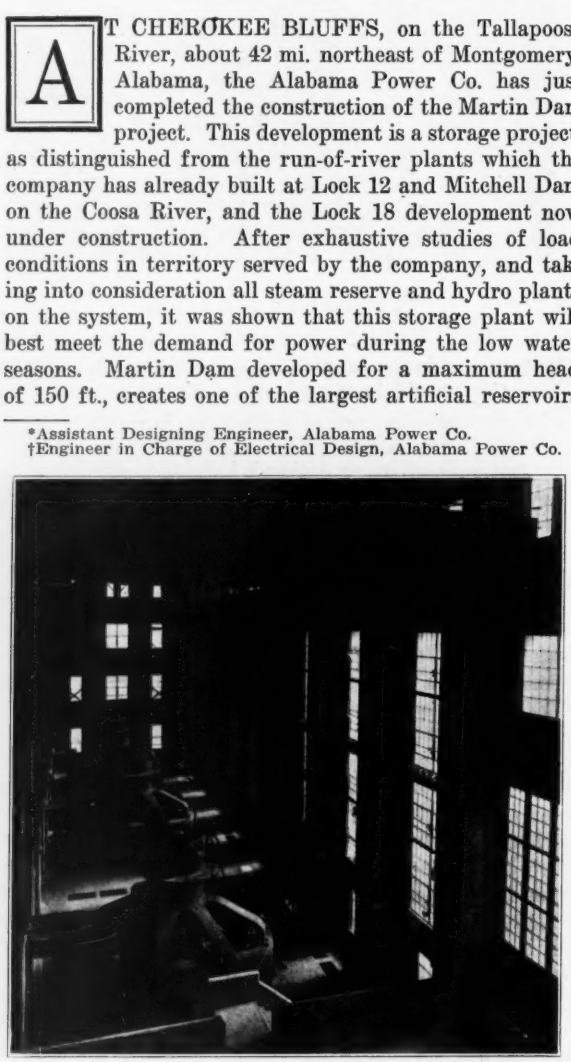


FIG. 1. THREE 45,000-HP. HYDRAULIC TURBINES DRIVE 37,500-KV.A. GENERATORS; SPACE IS LEFT FOR A FOURTH SIMILAR UNIT

Function of Martin Dam in the System

The primary purpose of the Martin Dam project is to save steam plant running during low water season when it is proposed to draw the reservoir down not to exceed 60 ft. The generating capacity for initial installation is 135,000 hp. at full head reduced to 60,000 hp. at maximum drawdown. During the high water season in the late winter and early spring months, the Martin reservoir will be allowed to fill while the run-of-river plants on the Coosa River are carrying the hydro plant load. In addition, this plant will be called upon to operate in peaks of load curves during the filling period, when relatively large kilowatt capacity can be supplied with a small amount of water. The company owns two other plants immediately below Martin Dam, known as Upper and Lower Tallassee. These plants will be reconstructed in the near future so as to utilize more fully the full fall of the Tallapoosa River and the regulated flow made possible by the storage at Martin Dam.

Careful subsurface investigations were carried on to determine the rock foundation, both in river-bed and on either abutment. A total of 28 diamond drill holes were sunk in the dam site. The predominating rock structure supporting the dam is of silicified schist formation of varying composition, including pockets of quartzite. Results of the diamond drilling, as well as the reports of eminent geologists, give every reason to believe that the foundation material is suited to sup-

port the dam and power house structures. To reduce to a minimum any possibility of rock erosion below the main spillway section, an auxiliary dam was constructed to form a water cushion and dissipate the energy of water falling a height of 150 ft. over the spillway, as will be described later in this article.

Referring to Fig. 2 and to the headpiece, the project consists of the following major divisions: power house, headworks, spillway and retaining sections of dam, earth dike on east abutment, auxiliary dam, and substation.

The power house building is of concrete, brick and steel, with roof of Spanish tile. The general plan of building is in the form of the letter L, the main building housing the generators, while the annex section at west end houses the control room, offices, etc. The substructure and all floors are of reinforced concrete construction, the main generator floor and passages being treated with a floor finish of red Colormix compound squared off into 12-in. squares. An elevator is conveniently located at west end of power house. The first floor of annex section is the repair floor where general repair work can be carried on. This repair floor is spanned by the 200-t. power house crane which travels the entire length of the generator room. The first floor also contains the pump room where all auxiliary pumps and air compressors are located. The second floor consists of locker rooms, store room and load dispatcher's office. On the third floor is located the guest room, battery room and terminal board room. The fourth floor includes the entrance lobby, women's rest room, superintendent's office and control room. The roof is of gable design supported on steel roof trusses. To prevent condensation on it, gypsum pyrobar slabs were placed underneath the tile.

Design of draft tube was obtained after thorough investigation and tests in the company's laboratory, the resulting design being a modified Mitchell Dam type of tube. This tube shows high efficiency and presented no difficulties in construction.

Headworks Section and Equipment

Constructed between the spillway and west retaining section, the headworks section contains the steel penstocks, head gates, stop logs, trash racks and gate-operating mechanism. As is seen from Fig. 3, the accompanying cross section through headworks and power house, the headworks section joins the power house substructure at an east and west expansion joint, thus making each section independent of the other structurally. With the electrical arrangement as shown, the space between power house and headworks was utilized to good advantage for bus vaults and transformer yard. The headworks section for each generating unit contains three inlets 24.6 ft. high and 9 ft. wide, converging to a common 20-ft. diameter concrete penstock which joins a 20-ft. steel penstock. Each penstock opening is provided with steel penstock gates, designed for a maximum head of 96 ft. The gate used is a modified wedge gate with sloping seal, supported on fourteen wheels of 30-in. diameter with 6-in. face. A bypass gate is provided to equalize water pressures to facilitate raising of gate. The penstock gates are raised by a 50-t. gantry crane on headworks deck. In raised position the gates are suspended on a toggle lever latching device mounted on deck. The downward speed of the gate is retarded by two hydraulic cylinders with orifices in the pistons designed as to release enough water to allow gate to drop at a speed of one foot a second.

Trash racks are constructed in sections sliding in grooves on nose of headworks piers. Each section is of 4-in. by ⅜-in. steel bars, with 4-in. clear opening. The trash racks are fitted with two perforated compressed air pipes operating under 125 lb. pressure. These air jets dislodge the trash, causing it to float to the surface. In addition, steel stop logs are provided.

To keep the logs away from the headworks, a trash barricade was constructed diagonally across the forebay from east end of headworks to the west bank of lake. This trash barricade was constructed of air tight oil drums with vertical timber baffle, all tied together with cable so as to float on the water and form a trash barrier about four to five feet deep.

Spillway Section—Gates and Operating Equipment

The Tallapoosa River at the dam site did not provide ample spillway capacity with a straight dam from bank to bank without excessive excavation on abutments. To provide the necessary length to pass the river under extreme flood conditions, the spillway section of the dam was arched in plan with radius of upstream face equal to 530 ft.

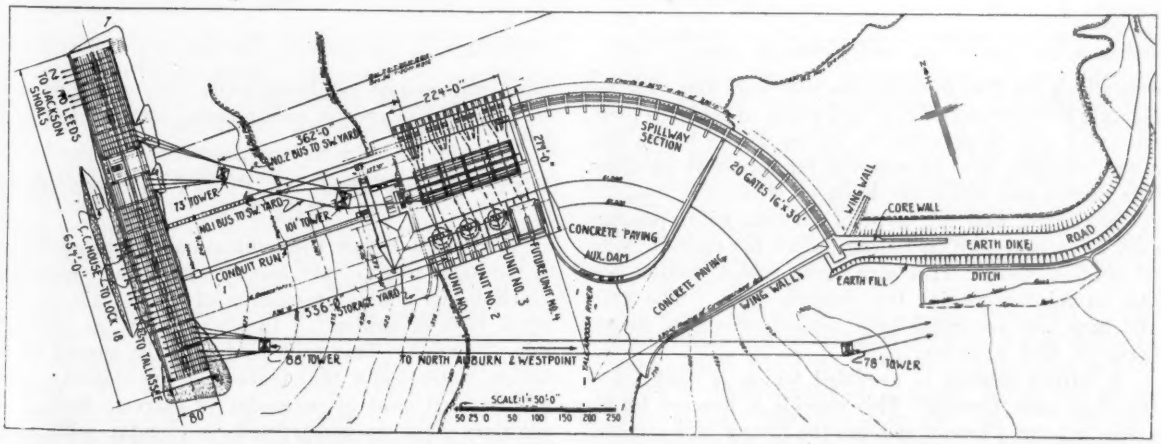


FIG. 2. GENERAL PLAN OF MARTIN DAM PROJECT, SHOWING POWER HOUSE, SPILLWAY, EARTH DIKE, AUXILIARY DAM AND SUBSTATION

The spillway dam is a gravity section, no arch action being considered in the design. Section of dam at crest, beginning 8.44 ft. from upstream face is a parabolic section with equation $Y^2 = 32X$. Slope of downstream face is 0.85 meeting the apron, which is constructed on radius of 50 ft.

There are installed twenty steel spillway gates of modified stoney type, for openings 16 ft. high by 30 ft. long. Gates are sealed at the bottom by a lead strip poured in the groove on the spillway crest immediately under the bottom of the gate. The side seals are obtained by means of 3-in. extra heavy pipe stanching rods which are free to move into side slots and close the opening between end of gate and guide in concrete piers. An extra gate is provided to use as a stop log in case a spillway gate is to be removed for repair or painting. The guides and track are built of structural steel, all prefabricated, and set in piers between gate openings, each structural unit including guides for opposite sides of six-foot piers. This structural basket section also acts as reinforcing for the concrete piers. The gates and stop logs are lifted by a specially designed gantry crane of 40-t. capacity.

A lifting shackle is provided which is designed to travel in gate grooves. This shackle is lowered by the crane to point where it engages the lifting lugs attached to the spillway gate. When the gate is raised by means of a crane to a height where it clears the water surface, the gate is suspended on latching posts located on the spillway deck between gate openings.

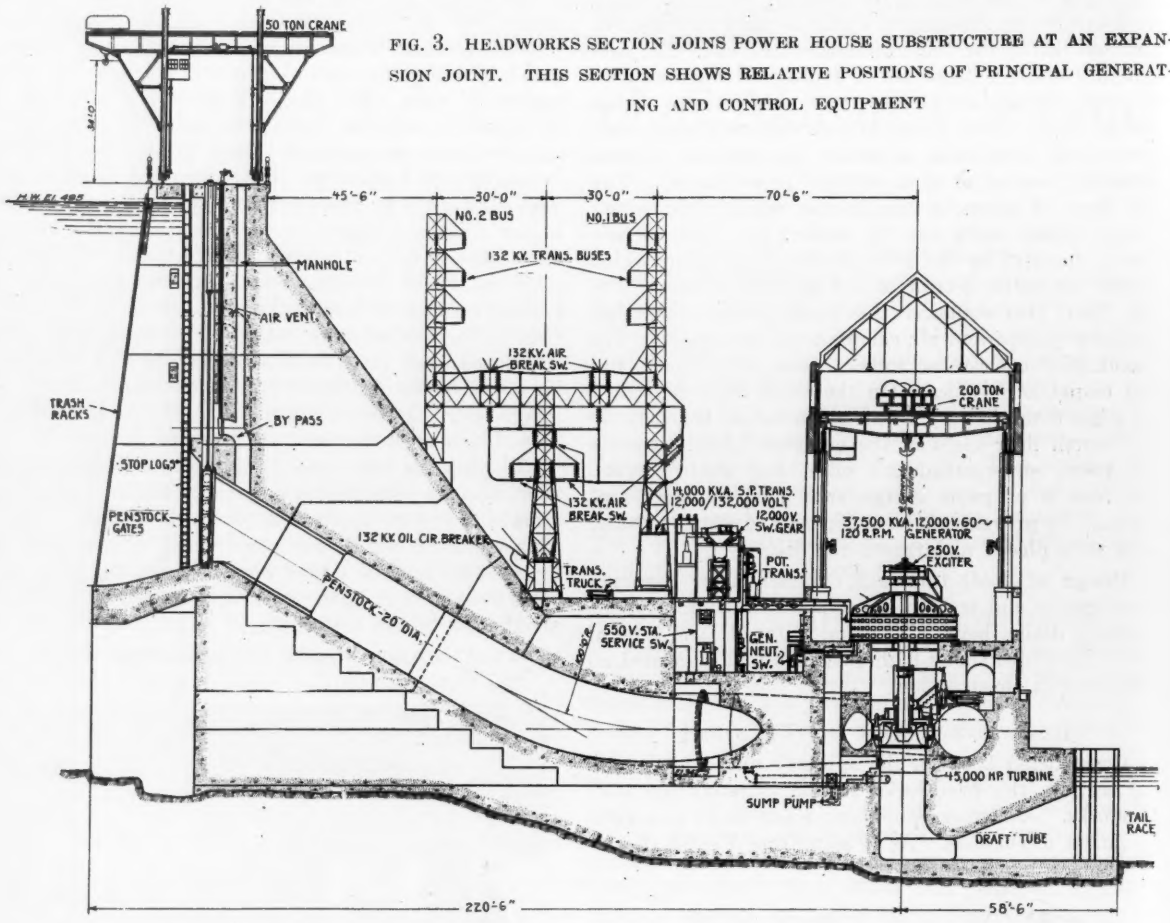


FIG. 3. HEADWORKS SECTION JOINS POWER HOUSE SUBSTRUCTURE AT AN EXPANSION JOINT. THIS SECTION SHOWS RELATIVE POSITIONS OF PRINCIPAL GENERATING AND CONTROL EQUIPMENT

Earth Dike

In order to fill a depression in the abutment immediately east of the concrete dam, an earth-retaining dike was constructed. This dike also furnished an excellent roadway for approach to the dam. The upstream slope was paved with riprap, and imbedded in the dike was a concrete core wall joining the end of the concrete dam, extending about 200 ft. and carried down to the underlying hard schist stratum. In addition to the dike, two concrete retaining walls were constructed on the east bank to protect embankment section adjacent to dam.

Auxiliary Dam Helps to Prevent Erosion Below Main Dam

To protect further the foundation rock below the toe of the dam, an auxiliary concrete dam was constructed which forms a pool or cushion of water 22.5 ft. deep below bays of spillway 1 to 12, inclusive, as shown in Figs. 2 and 4. This pool dissipates the energy of the falling water below that section of the spillway which will be used most often except in extreme flood. The auxiliary dam, as constructed, is circular with inside radius of 117.71 ft. The top width of the dam is 10 ft. The minimum base width is 39 ft., height above

paving 22.5 ft., and total length, including transition section at junction with dam, 367.7 ft. The entire area of rock between auxiliary and main dam has been covered with concrete paving. Immediately east of auxiliary dam, or below bays 13 to 20, inclusive, of spillway, the loose rock was excavated and then paved with concrete for 250 ft. below the toe of the dam, thus protecting, with the auxiliary dam, the entire downstream rock surface for a distance of about 250 ft. below the toe of the dam. With this protection can be no possible chance of any undermining or erosion of rock within the vicinity of the major spillway section.

Clearing Reservoir

One of the major problems in connection with the construction work was the clearing of the reservoir, involving some 33,800 acres. All work was carried on in co-operation with the state health department. All timber and brush within the drawdown area, between the 430 and 490 contours, was removed or burned. It is estimated that 18,000,000 ft. of merchantable timber was cleared from this area, 80 per cent of which was utilized at the dam or sold. The work was done both under contract and by company forces. At certain times as many as 2000 men were engaged in this work, local farm labor being employed as far as possible. As water was raised in the lake, about 50 men were employed to spray the lake with oil to prevent mosquito breeding. In addition, hatcheries were established throughout the basin for the purpose of breeding Gambusia or top minnow. As the water was raised in the lake, these Gambusia were released and helped to exterminate the wigglers of the malaria-bearing mosquito along the shore lines where the larvae were likely to be found.

Initial installation, Fig. 1, consists of three turbines with provisions for a fourth. Two were furnished by the Allis-Chalmers Manufacturing Co., and one by the I. P. Morris division of the William Cramp and Sons Ship and Engine Building Co. All are 45,000 hp., single runner Francis type, operating under a maximum head of 150 ft., and suitable for a 60-ft. drawdown of pool. Each scroll case is of steel, ¾-in. thick, imbedded in concrete. Access to the inside of scroll case is through a man-hole connecting to the sump chamber. The outside horizontal dimension across the scroll is 44 ft. 3 in. at its largest point.

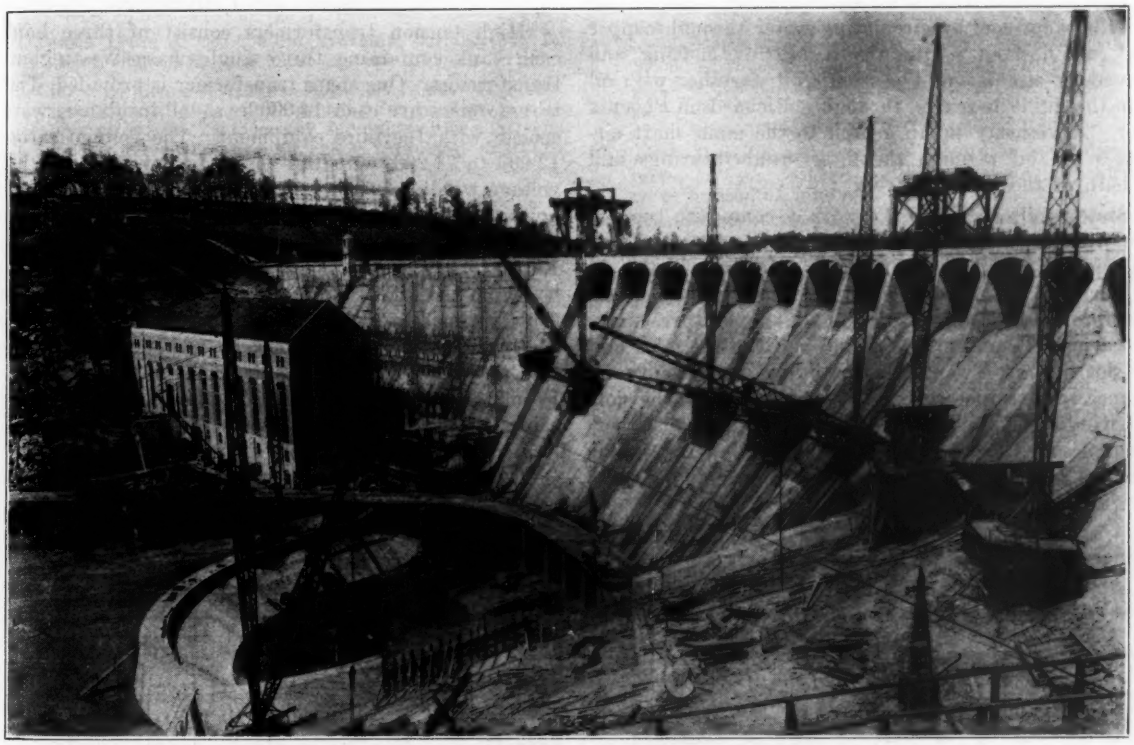


FIG. 4. SPILLWAY AT THE RIGHT WITH AUXILIARY DAM TO MINIMIZE EROSION, POWER HOUSE, AND SUBSTATION ON HILLSIDE FORM THREE ITEMS OF INTEREST

Guide vanes, of which there are twenty, are actuated by oil cylinders from a pressure tank at each turbine, 125 lb. pressure being maintained by means of a continuously running pump taking its suction from the discharge tank. All receiver tanks are connected together by means of a 6-in. extra heavy header, so that pressure can be maintained in any receiver in case of failure of one pump or motor. Normal operation, however, is on the unit system with each governor receiving its oil supply from its own tank.

Governors are of two types, those furnished by the Allis-Chalmers Company being actuated by fly-balls on the main shaft, while the I. P. Morris machine is governed by fly-balls driven by a motor, power for which is taken directly from the generator leads. Governors are located in an arch of the ring wall supporting the generators. A chase cut in one side of the arch wall, handy to the governor, contains the gages and operator's

valve for braking the generator when wicket gates are closed.

Three generating units furnished by the General Electric Co. are 37,500-kv.a., 12,000-v., 3-phase, 60-cycle, 120-r.p.m. machines with 250-kw., 250-v. exciters, direct-connected to the main generator shaft. These exciters are mounted over the thrust bearing and are supported by the bearing case. Total weight of the rotor, shaft and waterwheel, including water thrust, is 650,000 lb., and is carried by means of a 60-in. General Electric standard spring-supported thrust bearing, having a normal rating of 800,000 lb. The load is transmitted through a steel hub and eight bracket arms to the stator frame. An upper and lower guide bearing take care of the lateral motion of the main shaft.

Lubrication of the thrust bearing is by oil bath, the oil being kept cool by circulating water through copper pipe coils located in the thrust bearing housing and cleaned by circulating a portion of it, together with oil from the guide bearings, through a Richardson-Phoenix filter. A viscosity pump geared to the main shaft circulates the oil through the filter, guide bearings and oil bath of the thrust bearing.

Stator coils are insulated with a composite type of insulation consisting of part mica and part varnished cambric. A number of half-lapped layers of mica in the form of tape are applied adjacent to the copper, therefore located where the highest temperature exists, the varnished cambric being used between the mica and the slot lining. Twenty thermocouples and twenty resistance type temperature coils are imbedded in the slots and windings for observing temperature of coils, thermocouples are located also in the step bearing, guide bearings and in the incoming and outgoing air passages.

For emergency excitation a spare motor-driven exciter is provided, which may be connected to any generator. This machine and all switching for it are controlled from the bench board.

The station is built on the unit plan, each generator supplying its own bank of power and station service transformers. Paralleling is done on the high tension side of the main transformer bank of each unit. The 12,000-v. leads from the generators are of ½-in. by 4-in. copper bars supported on 25-kv. insulators and pass through the station wall, under the ceiling of the transformer deck, then through outdoor bushings to the generator oil switches and to the transformers located on the deck between the toe of the dam and the power house superstructure.

Transformers and Connections

High tension transformers consist of three banks, each bank containing three single-phase Westinghouse transformers. One spare transformer is provided. These transformers are each 14,000-kv.a., oil-insulated, water-cooled, with Inertaire equipment. The voltage ratio is 12,000 to 71,200, with tap changing device in the high voltage winding. The banks are connected delta on the low side and star, with solidly grounded neutral, on the high side, the high tension line voltage being nominally 110,000.

From the high side of the transformer bank connections are made to the 110,000-v. busses through disconnecting switches, transformer oil switches and selector disconnect switches to duplicate high tension busses. From the high tension busses two leads of 750,000-c.m. cables, supported on steel towers, supply the substation located on the hill about 550 ft. away.

Generator oil switches and disconnecting switches

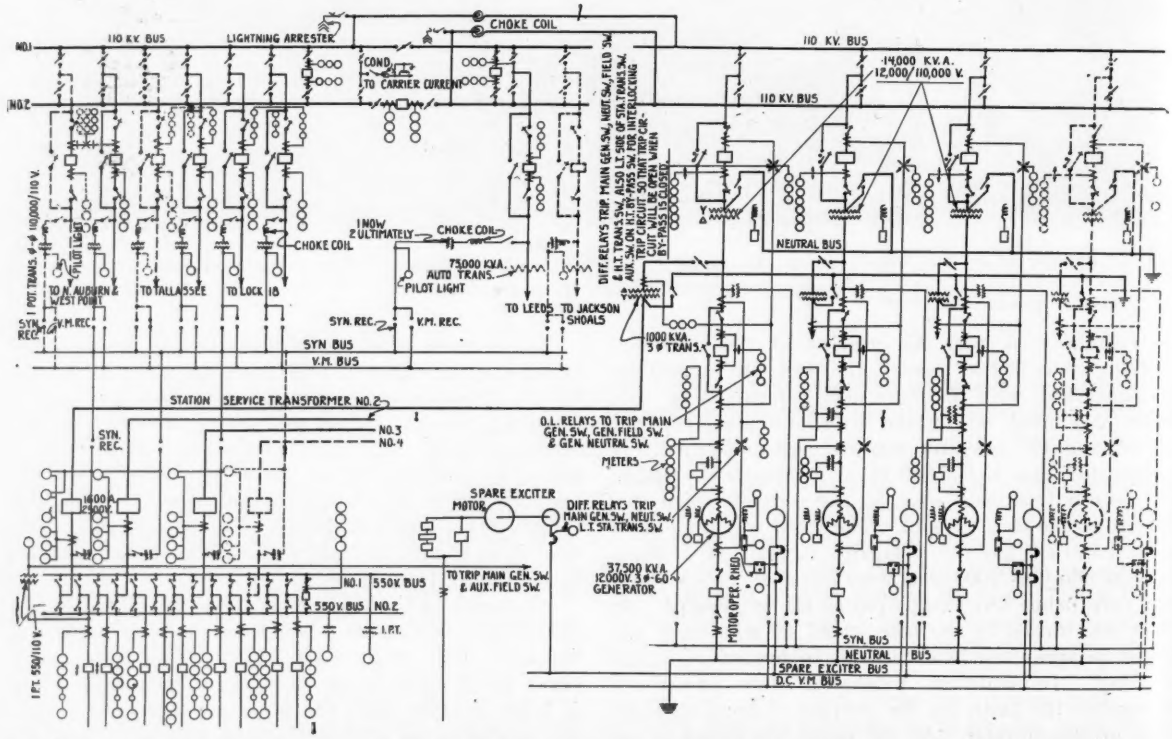


FIG. 5. SINGLE LINE DIAGRAM OF ELECTRICAL CONNECTIONS AT MARTIN DAM, SHOWING PROTECTIVE DEVICES AND SWITCHING ARRANGEMENTS

are listed on the list of equipment. Station service oil switches and duplicate busses located on the 370 deck, are enclosed in concrete structures. Every effort was made to provide a structure which would give a maximum amount of protection to the station auxiliaries, the more important equipment having duplicate feeders.

Power is supplied the station service bus from station service transformers, fed through motor-operated disconnect switches from the main transformer delta. There is provided one three-phase, 1000-kv.a., 12,000 to 550-v., self-cooled transformer for each unit.

All conduit for control cables terminates on floor elevation 425, which is the floor immediately below the control room and is called the terminal room. On this floor are located two rows of terminal panels.

From the terminal board, located at elevation 425, short lengths of conduit run straight up to the test panels on elevation 435 or, where necessary, to other sections of the boards. This terminal room served two purposes. First, it allowed the pulling of the control cable from two ways so that construction work could be carried on at several points at once, allowing the work of wiring the panels to go ahead without interfering with pulling of cables. Second, which is of more importance, it provided ready means of connecting panel to panel and afforded space for making any changes in the wiring scheme after the initial installation without disturbing the wiring on the backs of the panels. All control cable together with power cable was manufactured by the Okonite Company to specifications furnished by the Alabama Power Co.

The control room, located on elevation 435, contains

Principal Equipment in Martin Dam Plant

Hydraulic Turbines and Mechanical Equipment

3 45,000-hp. hydraulic turbines for 145-ft. head, speed 120 r.p.m., complete with governor; one turbine built by I. P. Morris Corp., two by Allis-Chalmers Mfg. Co.

1 James Leffel & Co. 100-hp. hydraulic turbine, 145 ft. head, 900 r.p.m., for house service.

3 Cleveland Crane & Engineering Co. cranes. One 50-t. gantry with 10-t. auxiliary hoist for headworks gate operation; one 40-t. gantry for spillway service; one 200-t. overhead traveling crane with 20-t. auxiliary hoist for power house.

2 Allis-Chalmers Mfg. Co. 1200-g.p.m., 50-ft. head centrifugal pumps, direct-connected to 550-v. motors, for transformer cooling water.

2 Allis-Chalmers Mfg. Co. 100-g.p.m., 300-ft. head centrifugal pumps, direct-connected to 550-v. motors, for station service.

3 Goulds Pumps, Inc., sump pumps, 4-in. discharge, 30-ft. head, automatic float control, for wheel pit sumps.

12 M. H. Treadwell Co. penstock gates with frames 11 ft. wide, 25 ft. high, weight 20½ t. each.

20 M. H. Treadwell Co. spillway gates and frames, 16 ft. deep, 30 ft. wide, weight 20 t. each.

1 De Laval Separator Co. No. 600 portable centrifugal oil purifier.

2 Sullivan Machinery Co. air compressors, each 12 in. by 12 in., 337 c.f.m., one automatic and one non-automatic, complete with direct-connected synchronous motors and, one 4 ft. by 8 ft. by 6 ft. steel air receiver.

3 5000-gal. oil tanks, steel.

Generators and Auxiliaries

3 General Electric Co. main generators, each 37,500-kv.a., 12,000 v., 3 phase, 60 cycle, 120 r.p.m. complete with direct-connected exciters and motor-controlled main field rheostats.

1 General Electric Co. house generator, 100 kv.a., 80 kw. at 0.8 p.f., 550 v., 3 phase, 60 cycle, 900 r.p.m.

1 General Electric Co. spare exciter motor generator set, 250 kw., 250 v. d.c., driven by 550-v., 3-phase motor.

1 General Electric Co. battery-charging motor-generator set, 15 kw.

1 The Electric Storage Battery Co., 70-cell lead storage battery.

Switching and Protective Equipment

16 Condit Electrical Mfg. Co. oil circuit breakers: three 7500-v., 1600-amp., s.p., for generator neutrals; nine 15,000-v., 600-amp., 3-pole, for 550-v. feeders; four 7500-v., 1600-amp., 3-pole, for 550-v. bus feeders and bus tie.

14 General Electric Co., 3-pole oil circuit breakers; three 25,000-v., 3000-amp., for main generator leads; eleven 132,000-v., 600-amp., for high tension switching.

Principal Disconnecting Switches

9 Electric Power Equipment Corp. 3-pole, 25,000-v., 3000-amp., outdoor disconnects, gang manually operated, three horizontal, nine 45-deg.

34 Delta-Star Electric Co. 135,000-v. outdoor disconnects, gang manually operated; 26-units, 3-pole, 600-amp., 5-units, 2 pole, 600-amp.; 3-units, single pole, 400-amp.

6 Electric Power Equipment Corp. 25,000-v., 600-amp., motor-operated outdoor disconnects, three 3-pole, three single-pole.

23 Delta-Star Electric Co. 135,000-v., 3-pole outdoor motor-operated disconnects for 600 and 800 amp.

32 Electric Power Equipment Corp. indoor manually-operated disconnects; 6 single-pole, 15,000-v., 2400-amp.; 8 three-pole, 2500-v., 1500-amp.; 18 three-pole, 2500-v., 600-amp.

2 General Electric Co. outdoor dry type lightning arresters, 132,000-v., 3-phase, 60-cycle.

Transformers and Miscellaneous

10 Westinghouse Elec. & Mfg. Co. power transformers, each 14,000 kv.a., 110,000 to 12,000 v., single phase, oil insulated, water cooled.

3 Westinghouse Electric & Mfg. Co. auxiliary service transformers, each 1000 kv.a., 12,000 to 550 v., 3 phase, self-cooled.

2 Main control boards; one 15-section bench; one 19-panel vertical; auxiliary boards for watt-hour and totalizing meters; and station service; steel operator's board.

1 Warren master clock with three secondary clocks, for maintenance of constant average frequency.

Selsyn indicators for signal system, forebay and tail-race water level indicators.

Outdoor steel switch and bus structures for transformer yard, switchyard, etc., furnished by American Bridge Co.

1 Westinghouse Electric & Mfg. Co. 250-watt carrier current communication system, using Wireless Specialty Co. coupling condensers.

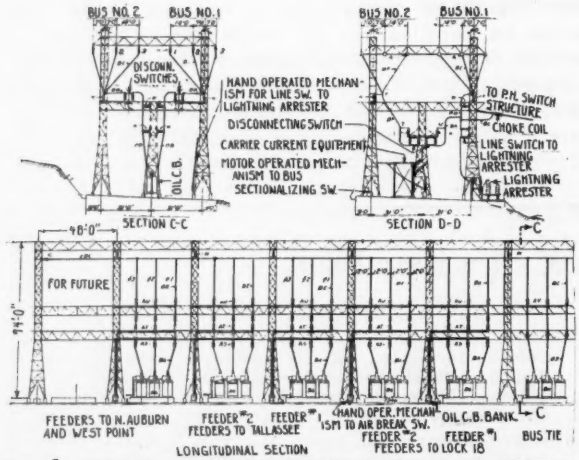


FIG. 6. SECTIONS THROUGH VARIOUS PARTS OF SUBSTATION

a control desk of 14 sections on which are mounted the control switches, mimic busses and exciter field rheostats. This desk is backed by a 90-in. vertical panel board on which are mounted all relays and indicating meters. Control, both for the generating equipment and for the high tension outgoing lines from the substation on the hill, is accomplished with this board.

A totalizing board containing eight panels is set at right angles with and to the left of the main board. This board mounts all the Leeds & Northrup recording temperature indicators for generators and transformers together with recording watt meters and watt hour meters for generators, power transformers and station service transformers. Space also is provided for totalizing meters, recording voltmeters and Selsyn indicators for head-water and tail-water levels.

At right angles to the main board and on the right is the board containing battery control, lighting and station service panels, of which there are seven panels in all.

The generators being star wound with all phases brought out and the neutral solidly grounded, current transformers are inserted in the neutral leads ahead of the star connection for differential protection. This differential protection extends from the generator neutrals to oil-filled current transformers on the transformer side of the generator oil switches. This arrangement provides protection against failure of an oil switch bushing in addition to the usual protection of generator windings and leads. Current transformers exterior to the bushings of the oil switch were used in order to accomplish this.

General Electric IJ-7 relays were used for generator protection. The high tension transformer banks also have differential protection, this extending from the bushing type current transformers in the 110-kv. oil switches to dry type current transformers in the main generator leads, giving an overlapping protection for both generator and transformer banks. The transformer differential relays are General Electric type PQ-6. Inasmuch as all oil switches are provided with bypass disconnecting switches, should the generator differential relays operate while running on the bypass switch, the transformer bank oil switch will trip together with the generator field and neutral switches. Overload relays protect all machines, transformers and feeders.

Energy for operating oil switches, governor adjusting motors and emergency lights is obtained from a 70-cell, type F-11 Box, Manchester storage battery. The normal operating voltage is 147 v. This high value of battery voltage is necessary, due to the distance between the power house and the high tension substation. A 15-kw. motor-driven battery-charging set normally floats on the line.

Signals for machine operation are transmitted from the control room to each governor stand by a Selsyn signal system which was worked out by the Alabama Power Company, and is now built by the General Electric Co. as standard equipment. Indication of the water levels at headworks and tail-race is also obtained by Selsyn indicators actuated by floats. Recording gages are provided also, which are mounted on the switchboard. Due to the large acreage of impounded waters, it was necessary to graduate the scales of these instruments in feet and tenths of feet. The positions of the gate openings of the turbines and of the contact arms of the general field rheostats are also indicated on the switchboard by Selsyn indicators.

A load dispatcher's board is located in the control room, built of light steel angles and $\frac{1}{8}$-in. steel plates. A single line diagram of Alabama Power Co. Southern Operating Division is painted on these plates. Holes are drilled in the plates for all oil switches and disconnect switches. Sheets of thin white paper with the switch numbers painted thereon are pasted over the openings and the whole board is backed up with plate glass sheets corresponding in size with the steel plates. Lights are placed at intervals in the interior of the structure and, as all sides, top and bottom are inclosed, the switch numbers are plainly visible from a distance. A small peg over each hole allows a colored celluloid tag to hang over the hole which gives a quick indication of the position of the switch.

A Warren master clock in the control room allows the plant frequency to be regulated as an accurate

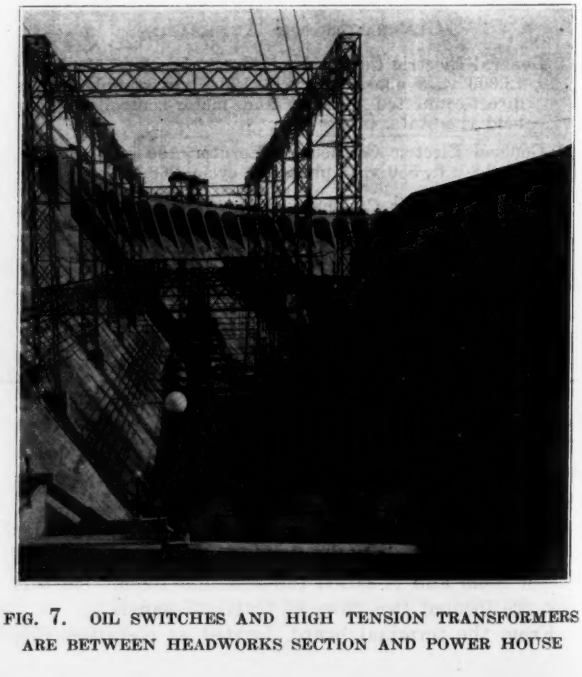


FIG. 7. OIL SWITCHES AND HIGH TENSION TRANSFORMERS ARE BETWEEN HEADWORKS SECTION AND POWER HOUSE

function of time, thereby causing the secondary clocks to indicate time correctly at other points on the system. Such frequency regulation also allows the use of Warren motors for driving charts of recording meters.

Substation Is Essentially a High Tension Switching Station

The substation, which is essentially a high tension switching station, located 550 ft. from the power house on the brow of the hill, is the distributing point for outgoing lines. A steel box tower and girder structure is used for support of disconnects and high tension busses.

In this structure, parts of which are shown in Fig. 6, are eight feeder bays, two bus tie bays, one bus section bay and two bays which are used for the tie lines from the power house feeding the substation. Each of the oil switches in the substation is General Electric Co. type K.O.-39, 132-kv., 600 or 800-amp. capacity, and is provided with a set of gang-operated switches on either side of the breaker. A bypass disconnect over each breaker is also provided. The switch groups are in turn connected through motor-operated disconnecting selector switches to each of the duplicate busses.

The two main busses are of 750,000-c.m. stranded copper cable strained on each end and with suspension insulators at each intermediate tower. Nine insulator discs are used at the strains and eight on the suspension strings.

For connections to switches and breakers 1-in. standard and 1-in. extra heavy copper tubing was used throughout, Burndy type connectors being utilized.

Control connections between substation equipment and control board in the power plant is by means of a duct line consisting of 120 conduits laid in concrete up the hillside.

Communication System

The plant is equipped with a full complement of communication equipment, including a local telephone system, with an eighty-line switchboard and 51 local telephones, 5 long distance wired lines, and one condenser-coupled, high-powered carrier current telephone for long distance communication.

For carrier current telephony a Westinghouse 250-w. equipment is used, coupled to the high tension lines by means of a set of condensers. The condensers used are 10 Wireless Specialty Apparatus Co. Model UC-2310, 22,000-v., 0.003-m.fd. capacity units arranged in two stacks of five units in series, the stacks being supported on porcelain insulators and connected in parallel. Two sets of these condensers form the coupling with the outside phase cables of the 110-kv. busses. Connection with either of the high tension busses is made by means of S. & C. Co. fuses and motor-operated disconnect switches. All carrier current equipment, except the couplings, is housed in a brick building located adjacent to the high tension switchyard.

The engineering department of the Alabama Power Co. made the studies and detail designs for all structures of the Martin Dam project. The design work was done under the supervision of O. G. Thurlow, vice president and chief engineer; J. A. Sirnit, designing engineer; F. E. Hale, assistant designing engineer; R. R. Stone, in charge of electrical design; and S. H. Woodard, consulting engineer. Construction work is under the supervision of A. C. Polk, construction manager and vice president of the Dixie Construction Co. C. C. Davis is superintendent of construction, and L. G. Warren, assistant superintendent in charge of engineering.

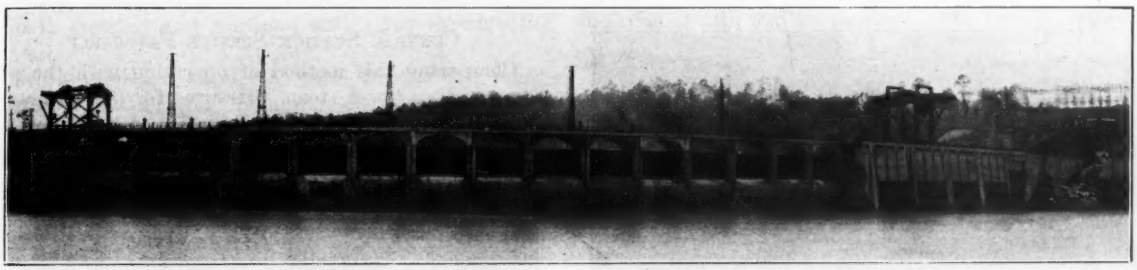


FIG. 8. UPSTREAM SIDE OF SPILLWAY AND HEADWORKS SECTION SHOWING CRANES FOR HANDLING GATES

Electric light has conquered darkness wherever man can normally live. Night flying is made practicable by the use of beams of artificial light. Underground operations of all kinds have long been carried on by artificial light. Least has been done with light at appreciable depths below water. Perhaps this is due partly to the increased difficulties which immersion in water presents.

In recent years several applications of electric lighting have been made in salvaging operations which show such lighting to be feasible. The most recent of these was in connection with the exploration of the submarine S-51 before it was raised to the surface. Great pressures of water and the deleterious effects of salt water are the chief difficulties; however, these have been successfully overcome by strong metal and glass housings and special precautions in regard to insulation. There appear to be many possibilities of under-water illumination, besides salvaging and scientific studies of the sea bottom by means of artificial light and photography. Lighting of the bottom of bathing areas in the interest of safety and the finding of the bodies of drowned persons would seem to be feasible. Artificial lighting has conquered many difficulties, and underwater lighting will some day be commonplace.

Boiler tube cleaners, when not in use, should be kept immersed in a bath of distillate or kerosene.

Power Applications in Various Industries

MIDWEST POWER CONFERENCE DISCUSSES INDUSTRIAL POWER PHASES AT ITS MEETING HELD IN THE CHICAGO COLISEUM ON FEBRUARY 15 TO 18

INDUSTRIAL power plant development and the use of power in steel, paper, and cement mills and in the food and packing industries was discussed at the meetings of the Midwest Power Conference. Abstracts of some of the papers read at that time are given below.

THE PRODUCTION AND USE OF POWER

Speaking on the above subject, C. H. Kane, Manager, Construction Department, Swift & Co., said, applications of power in the packing industry follow the development from crude to present advance methods of

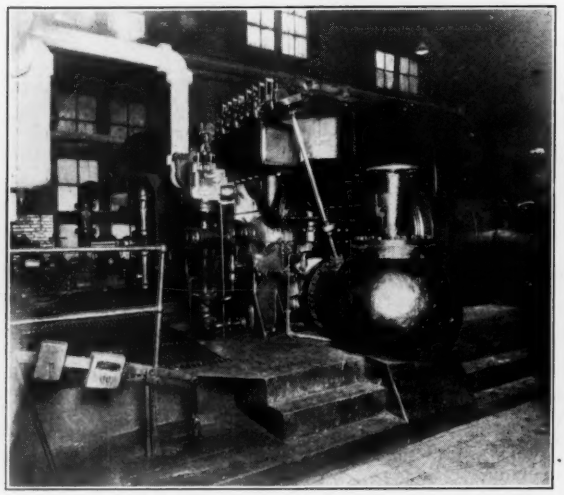


FIG. 1. EXHAUST STEAM TURBO-GENERATOR WITH A CAPACITY OF 3500 KW., FUNCTIONING WHEN SUPPLY OF EXHAUST STEAM EXCEEDS MANUFACTURING REQUIREMENTS

power production. In a few cases steam turbines have found their way into the power production, but generally speaking the character of the operations and the lack of a sufficient supply of condensing water eliminated the turbine as an important factor. The meat packing industry requires great quantities of both cold and hot water. The heating of this water, as well as the heating of buildings and a large part of the processing, may be done by low pressure steam, thus making possible the use of the exhaust steam from a great many of the pumps and prime movers.

In the case of compound condensing engines, to return the condensate to our boilers would mean to supplant the present barometric condenser with the surface type, which is hardly feasible in view of the lack of a suitable supply of condensing water, the packing industry depending almost entirely upon cooling water by circulating over cooling towers.

When exhaust steam is used, good thermal efficiencies are obtained where the demand for the steam can be properly balanced with the supply. Because of the low pressure, however, this usage is limited. Much thought and time has been given to the possibilities of generating higher steam pressures for the operation of power driven units, refrigerating machines, pumps, etc., with the idea of exhausting at pressures up to 150 lb. Such a system, however, is confronted with the great difficulty of bringing the requirements of processing and heating, which occurs about 8 hr. per day, in balance with the refrigerating machines, pumps and portions of the manufacturing load that are required over the 24 hr. day. Overhead and fixed investments are greatly increased with such a system, but where the packing plant is so located that it must look forward to the economical production of its own steam and power, such a plan has encouraging possibilities.

CENTRAL STATION SERVICE FAVORABLE

Comparing this method of operating with the plan of generating lower steam pressures for our processing and the purchase of central station service for our power requirements, where modern central station service and schedules are available, we find the balance in

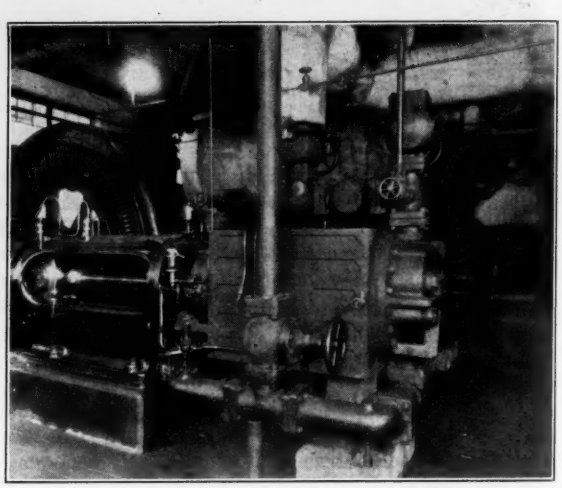


FIG. 2. STANDARD MEDIUM SPEED REFRIGERATING MACHINE DIRECT DRIVEN BY SYNCHRONOUS MOTOR MOUNTED ON THE SHAFT. FLYWHEEL IS ENTIRELY ELIMINATED. FLYWHEEL EFFECT IS PROVIDED BY ROTOR OF MOTOR. SPACE REQUIRED ONLY 588 SQ. FT. OF FLOOR SPACE. CAPACITY, 400 TO 500 T. REFRIGERATION

favor of using the central station service. Electrification of our present refrigerating machines will be greatly encouraged with the development by electrical manufacturers of slow speed synchronous motors, within reasonable investment cost, of from 500 hp. to 1200 hp. in size, and operating at a speed of about 60 r.p.m.

We have installed, in late years, a number of medium speed refrigerating machines, developing from 400 to 500 t. of refrigeration direct connected to synchronous motors, and in one of our plants we have removed the flywheel of a steam driven refrigerating unit and installed a synchronous motor on the shaft in its place. By dropping the connecting rod and the valve gear rod on the cross-compound engine, we operate the compressors on this unit with entire satisfaction. It is a convenient unit and, during the winter months, we can

easily pick up the disconnected rods on the steam engine and the valve gears and thus have available the exhaust steam. But it represents too much initial investment, and the change is only justifiable where very low power rate is available. It is believed that the meat packing plant of the present and the future will ultimately operate every power driven machine of whatever kind from central station service.

Our refrigerating system creates one of our greatest demands for power, and being a 24 hr. load with the maximum demand coming in the summer months and the minimum in the winter, it becomes a very desirable load from the central station standpoint. By no means, however, is the load reduced in the winter months in the same relation or proportion as would occur in ice making in business, as our very heavy live stock receipts begin in October and continue well along through the winter.

In our Chicago plant, the total horsepower represented by refrigerating, pumping, electrical drives for manufacturing, etc., will aggregate some 30,000 hp. divided as follows:

Steam driven refrigerating machine, about...	8,000 hp.
Combined steam driven and electric driven pumping equipment, about.....	5,000 hp.
Electrical power used for manufacturing produced by our own power plant, about.....	3,000 hp.
Electric power used for manufacturing supplied by the central station service, about..	12,000 hp.

Use of Power in Steel Mills

In his address on Steel Mill Power, Wilfred Sykes, Consulting Engineer, Inland Steel Co., said, at the present time the steel industry is largely electrified. With the development of a.c. distribution and increase in size and improvement in economy of the generating units it became possible to consider the use of electric motors for the main drive of the rolling mills. It is only a question of time until electricity is used universally for power purposes.

With the development of central power plants in the mills the use of electric motors for all purposes became more desirable and the facility with which electric power can be transmitted has been a material factor in effecting the layout of modern plants. The reduction in cost of power furnished by large central stations has made it desirable for many plants to purchase power instead of generating it themselves.

Turbo-Generators Displace Large Gas Engines

Rapid development of the turbo-generator and the use of higher steam pressure and superheated steam materially improved the economy of this power unit which is displacing the large gas engine plant in this field. There are a number of gas engine blowers in use and from a fuel standpoint these are the most economical units at the present time. However, their first cost is high and maintenance considerably higher than with turbo-blowers which represent the latest development in this field.

Turbo-blowers are, of course, dependent upon steam generating equipment which, within the last few years, has been greatly improved, so that efficiencies compare favorably with those of modern central station plants.

It is characteristic of a steel mill load that there will easily pick up the disconnected rods on the steam enthat there will be little correlation between the operation of the blast furnace plant and the power requirements. This is, therefore, not an ideal load for internal combustion engines as they should be operated near their rated capacities to obtain best economy and governing difficulties become serious with rapid load changes. Where gas engines have been used the practice has been therefore to install a certain proportion of the total capacity, usually about 30 per cent, of turbo-generators, which are used to carry the peak load and help regulate the system so as to obtain reasonably constant frequency.

Power Requirements of Mills

Power required for driving rolling mills varies with the type of mill and its product. The largest units are

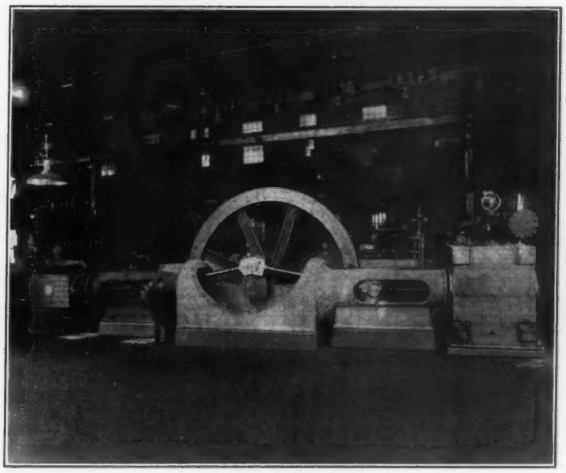


FIG. 3. CROSS COMPOUND DUPLEX STEAM DRIVEN REFRIGERATING MACHINE OF ABOUT 400 TO 500 T. REFRIGERATION CAPACITY. NOTE FLOOR SPACE IS ABOUT DOUBLE THAT OF UNIT SHOWN IN FIG. 2. THIS IS A COMBINATION STEAM AND ELECTRIC DRIVEN UNIT. MEDIUM SPEED SYNCHRONOUS MOTOR MIGHT REPLACE FLYWHEEL

used with the reversing mills, the motor driving the rolls developing momentary outputs of from 10,000 to 15,000 hp. and having an average load of 6000 to 7000 hp. The largest continuously rated motor installed at present for driving a mill is 9000 hp. but frequently several motors are used to drive different units of a single mill so the total may be higher. The service of reversing motors is probably the hardest performed by electric motors of any application.

Most of the continuously running mills are driven by constant speed motors but there is an increasing use of adjustable speed motors to enable mills to be run at the best speed for the particular product being rolled. As alternating current is practically universally used for power purposes, a tendency in recent years has been to use either rotary converters or motor generator sets to convert for direct current motors.

For a great many auxiliaries, where the service requires frequent starting or reversal, especially sturdy motors have been developed. Many applications in steel mills can be taken care of with ordinary commercial machines but most of the auxiliary drives around the

mills proper, have special mill type motors. These auxiliary drives usually do not exceed 100 to 150 hp. in single machines. The amount of power used for auxiliary purposes in steel mills is a very large proportion of the total, amounting frequently to one-third or more of the total power.

Future Development

Present tendency regarding development of power in steel mills depends upon the type of plant. In those plants with blast-furnaces, it is believed that the future practice will be to install efficient steam driven turbo blowers and turbo generators. Boiler plants will be developed to burn surplus blast furnace gas economically and provision for supplementary fuel will be frequently

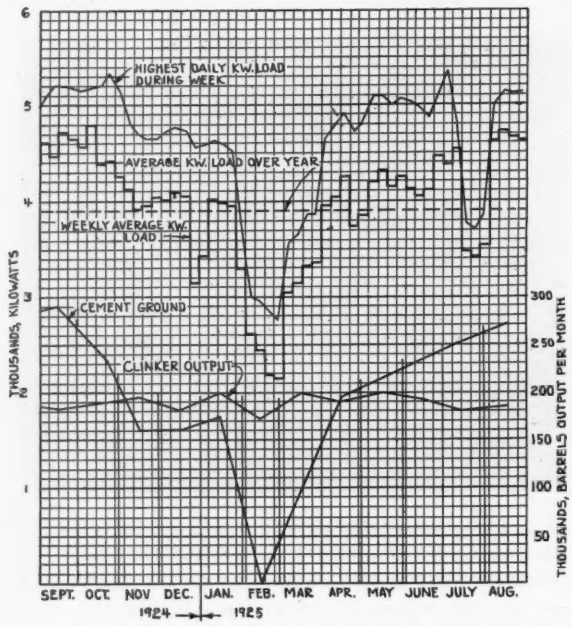


FIG. 4. SHOWING TWELVE-MONTH PERIOD LOAD AND OUTPUT CURVES FOR CEMENT PLANT

installed where low grade fuel, such as for instance coke braize, is a by-product in the plant. However, it will usually be found to be more satisfactory to burn solid fuels independently of the blast-furnace gas unless they are first pulverized. In some cases where blast-furnace gas is insufficient to supply the total power needs pulverized coal will be used advantageously with the same boiler settings that are suitable for blast-furnace gas. There will be a tendency to interconnect these plants with central station plants so that when excess power is available it can be delivered to the central station and the fuel value of the excess gas will be rendered available. At other times when the available gas is insufficient for the plants' power needs, power will be purchased from the central station.

In the case of steel plants not having blast-furnaces and located where central station power is available, it is believed that power can be purchased to advantage, instead of installing an individual power plant. This has been demonstrated in many cases and it is doubtful if any plant of this nature being built today will build a power plant of its own if central station power is available at reasonable cost. The steel plant is only justified in installing a generating plant if it thereby uses fuel that would be otherwise wasted.

A Cement Mill Considered as a Load and Power Producer

Power requirements of a cement mill, said J. H. Lendi, chief electrical engineer, Universal Portland Cement Company, in his address, are unique in that it operates at an exceptionally high load factor over a 24-hr. day, any departure from 100 per cent daily load factor being caused by incidental operating difficulties and not by essential interruptions in the process. Moreover, this condition persists over weeks and months except as influenced by holidays. In a year's operation the load factor is lowered because of a seasonal variation of demand for cement together with inadequate storage facilities for the finished product. A typical daily load factor would be 89 per cent. Figure 4 represents load conditions during 12 months' operation. The yearly load factor is over 71 per cent. A load of this sort at 80 per cent power factor is therefore very desirable from the standpoint of the power seller but the cement mill has the ability to furnish its own power cheaply.

Large Quantity of Waste Heat Available

Pulverized coal, which was first used by cement mills as a fuel, is now used in over 90 per cent of these mills in the United States. Finer grinding is, however, necessary in order to avoid contaminating the product with sulphur. Only 45 per cent of the heat necessarily produced by the combustion of this fuel can be absorbed in the chemical reactions. Therefore, 55 per cent is rejected as waste heat by the kilns as shown in Fig. 5.

Due to efficient operation and nature of raw materials the mills of Universal Portland Cement Co. produce one barrel of clinker for every 900,000 B.t.u. burned in the kiln and with the 55 per cent rejected they may operate the mill, using waste heat boilers. This permits of production of power at not more than 0.75 cents per kw-hr. As might be expected, the application of the waste heat boiler to the cement kiln meets with a number of new difficulties never before encountered by a boiler.

Effect of Abrasion

Gases issuing from the kiln are accompanied with a considerable amount of abrasive dust. High gas velocity which results in high heat transfer rate and therefore low first cost of boiler, would, in this case, also result in rapid deterioration of boiler tubes.

Among the lessons that were learned through experimentation are:

(a) Low gas velocity, not more than 30 ft. per second at any point in the boiler to prevent tube cutting.

(b) A uniform gas passage with no abrupt turns and little or no horizontal shelving is desirable.

(c) Liberal tube spacing to prevent dust bridges from forming and causing high local velocities.

(d) Accessibility to all parts in order to facilitate easy cleaning by means of air or steam lancing.

(e) A steel casing is of first importance.

(f) Ample means should be provided for draining dust lodging in the boiler.

The extreme limit of 30 ft. per sec. gas velocity to prevent abrasion is established particularly where there

is a component of velocity at right angles to the boiler tube, a condition unavoidable in any water tube boiler. It was verified that where the gas flow is parallel to the tube no cutting took place even at 60 ft. per second and all abrasion was confined to those locations where the gas flow turns to enter the following pass.

Use of Vertical Fire Tube Boilers

It would seem that a fire tube type of boiler with tubes vertically disposed would be ideal in this respect. A preliminary experiment of this nature is now being made but no data is yet available. The question to determine in the fire tube boiler is how high a gas velocity is permissible even though the gas flow is parallel to the tubes, for we must realize that in order to attain a reasonable heat transfer rate, a gas velocity sufficiently high as to cause turbulent flow is required and such a flow has a velocity component against the tube wall.

The second item as to uniform gas passage follows as a consequence of what has been said concerning gas velocity, because horizontally disposed parts in the gas passage generally form inaccessible pockets for the accumulation of dust, ultimately building up, causing high local velocities and therefore cutting. Again, in some types of boilers where brick baffling is used between spaces of high differential pressure, the difficulty of making a tight baffling causes short circuiting of gases and cutting in the interstices, even though the velocity is parallel to the tube. Dust should here seal the interstices but it does not and cutting is here particularly vicious.

The waste heat boiler is peculiar in that it takes heat as it gets it from the furnace that is primarily controlled with the object of making cement clinker. As a consequence there are conditions giving rise to secondary combustion and explosions, and in spite of explosion doors, these result in leaky boiler settings and consequent loss of boiler efficiency. The obvious remedy is a steel casing which will prevent air leakage. Figure 6 is a typical arrangement of waste heat boiler installation. There are two possible arrangements of connecting the boilers to the kilns, the first where an individual boiler serves each kiln, and second where the gases of the kilns feed to a common gas chamber which in turn connects to one or more boilers.

Dust in gases not arrested by the boiler pass on with the gas and are collected by a Cottrell Precipitator, returning to the system something like a ton of raw material dust per hour per kiln.

Improvements in Heat Balance and Costs in Factories of The Corn Products Refining Co.

In his address on the above subject, J. J. Merrill, Chief Engineer, Corn Products Refining Co., indicated that all the electrical generating units and all main water pumping units in their power plants today are centrally located. Electric current is generated either by means of steam turbines or reciprocating steam engines direct connected to generators and the pumping units are centrifugal pumps direct connected to either motors or steam turbines.

In the design of a new plant or department, the engineer is told what products are to be made and the quantity of each. A heat balance is then made, the process departments are designed to conform to this heat balance and the power house is designed to supply this heat in the most economical way, considering the entire factory as a whole.

Decision as to the type of motive power is determined by the requirements of the factory for low pressure steam. The units are chosen so that at no time will more steam pass through them than is required as low pressure steam by the manufacturing departments. Our steam turbine acts as a reducing valve, removing some heat from the steam during the reduction to produce electricity and pump water. This change from many units of small size scattered throughout the factory to a few larger and more economical units has had much to do with the decrease in total coal consumption.

Improvement has been made in our heat balance in three ways, namely, a more efficient operation of the original apparatus, replacement of apparatus with more efficient apparatus, in many instances increasing unit

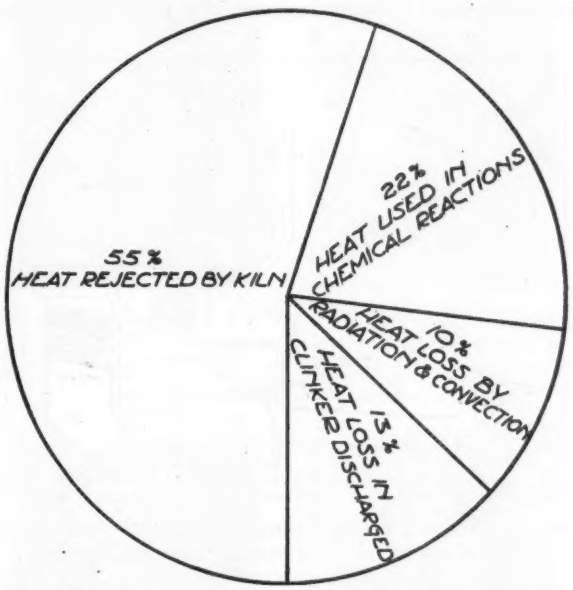


FIG. 5. DIAGRAM OF HEAT BALANCE OF A TYPICAL CEMENT KILN

sizes, and using heat which was formerly discharged to the atmosphere or sewer.

Demand for Water Great

Large quantities of water are needed both for condensing vapor from evaporators and for other process purposes. Under older methods of operation the vapors from these evaporators passed directly to a barometric condenser, were condensed and the heat in them carried away to the sewer with the water used for condensing purposes. This heat is over 1000 B.t.u. for every pound of water evaporated from the liquor and we evaporate as much as 160 lb. of water from the liquor made from one bushel or 56 lb. of corn. Here is a chance for a great heat loss.

In addition to this condensing water, from 40 to 50 gal. of well water and condensed steam is used directly in the process per bushel of corn ground. This is heated to temperatures varying from 100 deg. to 210 deg. F., and requires heat either from the coal direct, or indirectly from steam, or else in some way from heat rejected to the sewer in finishing the product. By

load could be increased until the flame point reached into the fire tube without impairing the efficiency.

using a thoroughfare heat interchanger between the evaporator and barometric condenser, a considerable amount of steam was saved and condensed vapor from condensers returned to the system. This reduces the quantity of both process water and condensing water to be pumped.

Water at 210 deg. F. is used for washing purposes. A few years ago this was rejected to the sewer after being used. Today this is passed through a heat interchanger reducing its temperature to 130 deg. and heating other liquors which were formerly heated by steam. Recovery of this heat in this one factory, amounted to the equivalent of 500,000 lb. of steam per day or 30 t. of coal. All of the water used for process purposes was formerly heated from 60 deg. to 100 deg. by steam. It is now passed through barometric condensers on the

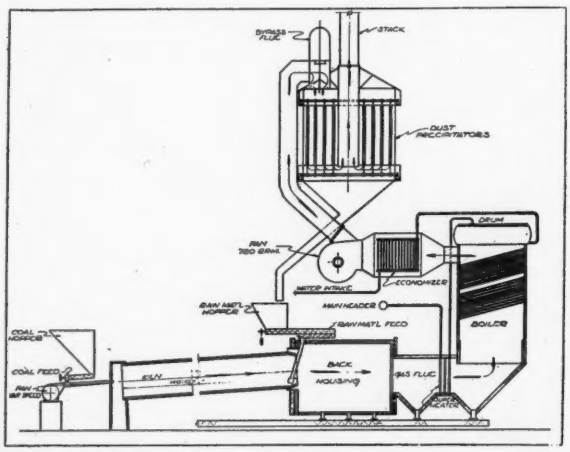


FIG. 6. SHOWING TYPICAL ARRANGEMENT OF WASTE HEAT BOILER INSTALLATION SHOWING DUST COLLECTOR

evaporators, thus reducing the quantity of condensing water required.

Formerly 40 lb. of steam was required in the driers for each bushel of corn ground. This is equivalent to 6 lb. of coal burned under the boilers. Improvements made in these driers materially reduced the number of units required and increased their efficiency. Direct fired driers with rotating steel shells were then developed. In these driers 6.5 lb. of water is evaporated per pound of coal fired. This is equivalent to 3 lb. of coal per bushel of corn ground, which is one-half of the coal used to do the same work when steam driers were used.

Flue Gas Used for Drying Purposes

At our Kansas City plant, the drying of feed is done by the boiler flue gases. Whenever there is a surplus of gas over and above the quantity required to do the drying, it is automatically discharged to the atmosphere. During any 24-hr. period, with the CO_2 varying from 12 to 14 per cent, the total amount of gas made is used in drying for at least 85 per cent of the time, and only a small amount is lost during the balance of the time. These gases leave the boilers, which are operating on an average of 280 per cent rating with no superheaters and carrying 225 lb. steam pressure, at an average of 660 deg., and leave the driers at an average of 130 deg. temperature, which gives us a greater overall heat economy than we could obtain in any other way. The consumption of coal chargeable to these driers is 2½ lb. per bushel of corn ground.

Heat balances are now made in each factory so that a perpetual record is kept and our exact coal cost for each product is known. In making this heat balance each productive department is charged with all the heat entering it whether coal used directly, power, steam, hot water, or heat in the product received from some other department. These charges are all reduced to B.t.u., then each department is given credit for all heat which it delivers, being charged with only that heat which it actually uses, or loses to the sewer. Such a procedure is followed for every productive department of a factory.

German Plants Going to Powdered Fuel

AT THE close of 1926, according to the Archiv. fuer Waermewirtschaft of January, 1927, Germany had 178 powdered fuel fired plants in operation and 81 under construction; 219 of these plants use powdered pit coal. The oldest boilers in these plants have been used about 3 yr. or 20,000 hr. Some valuable operating records were obtained in the plants of the Ruhr district.

Flat burners have proved better than round burners, for they assure a better mixture of air and fuel. This desirable feature is still better obtained in a burner having a zigzag opening. In one plant the replacing of a round burner with a flat burner increased the efficiency of the boiler plant 5 per cent.

In plants firing powdered fuel in combination with coke oven or smelting furnace gas, the alternating flow burners have proven especially acceptable. Supply of secondary air in various stages speeds combustion and shortens the flame.

The pear or ball-shaped chamber is still suitable for small combustion furnaces. An important factor is the load-carrying ability of the combustion chambers under various grades of fuel. Dr. Hold, in co-operation with others, made 40 comparative tests on three types of boilers. The specific combustion chamber loads were found to be: 25,280 B.t.u. per cu. ft. per hr. for the vertical tube boiler; 22,470 for the inclined tube boiler; and 33,700 for the single fire tube boiler. The latter boiler had a pear-shaped combustion chamber, the water-tube boilers had nearly pear-shaped chambers. The total average is thus about 26,960 B.t.u. per cu. ft. per hr. Anthracite, poor coal, rich coal, gas coal and gas flame coal gave practically similar results in the single fire tube boiler. The boilers under test had no wall and grate cooling equipment as found in modernly equipped plants.

On the inclined tube boilers the load fluctuated between 15,370 and 32,580 B.t.u. per cu. ft. per hr.; on the vertical tube boiler, between 22,470 and 26,960 whereby gas coal assured the highest and gas flame coal the lowest values. In the single fire tube boiler the

Welding Found Convenient for Buried Pipe

Years of Service in Underground Piping for Heating Systems Proves Practicability of Welding Pipe Joints. By Louis A. Foster

SOME FIFTEEN years ago it became apparent to those actively engaged in the construction of pipe lines carrying various gases and liquids, that a more permanent type of joint was most necessary. Increasing pressures and more extensive programs were being undertaken and the problems of adaptability, short life and maintenance, became paramount.

At this period, welding was finding its way into this field and becoming commercially practical. It was seen that in joining pipe by this medium it would reduce the number of joints to be made, make fewer chances for leakage, lessen repairs and was generally commendable. This was especially desirable, where pipe lines were buried underground. Ensuing years find welding developed to the extent that today there are hundreds of miles of welded underground pipes of all kinds throughout the country.

It is exceedingly common to find welding used in joining pipes conveying gas, water, oil, ammonia and steam underground. With specific references to the latter, welded joints are applied with gratifying results. Where necessary to maintain proper pitch or grade to eliminate condensate in underground steam lines, which is often difficult due to other street obstructions, welding is indispensable. Offsets of varying angles can be made by this medium resulting in considerable saving in investment. Early in 1914, in Indianapolis, where there is a large underground steam distribution system, welding was applied in connecting service lines to the main lines (see Fig. 1) with success.

FIG. 1. SERVICE LINES WERE WELDED INTO MAIN STEAM LINES IN 1914. ELBOW WOULD BE REPLACED BY BEND IN MODERN PRACTICE

It is clearly evident that many feet of service lines were saved by this application, as the necessity of paralleling the main lines with service lines back to a service outlet fitting was avoided.

Early in 1917 the writer was confronted with the problem of interconnecting two independent underground steam systems, which combined constituted some 6 mi. of lines, crossing each other at various points. These lines intersected at various angles, which made it extremely expensive to connect with standard fittings. Here again welding was applied with complete success, thus affording small street opening and a minimum of expense (see Figs. 2, 3, 4 and 5). In making a connection of this particular nature it is of course, most necessary to make a thorough survey of the location of the anchor points and the direction of expansion so that proper allowances can be made for pipe travel. In the case of illustrations 2 and 3 it was necessary to provide a swing joint. It was remote from the anchor point of the lines, while in illustrations 4 and 5 the reverse condition existed.

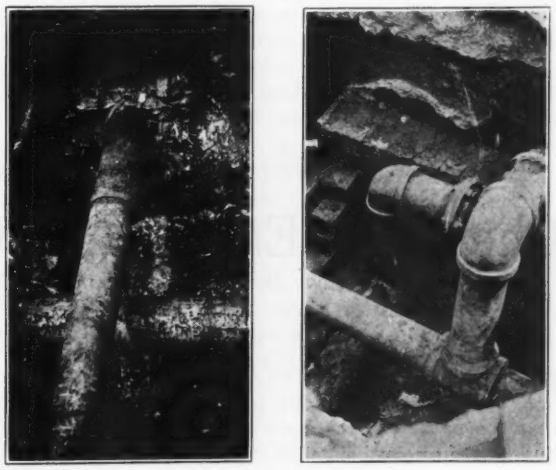


FIG. 2. INTERSECTION OF TWO UNDERGROUND SYSTEMS SHOWING WOOD BOX CONDUIT AND BAD PIPE CONDITION
FIG. 3. INTERCONNECTION OF PIPES IN FIG. 2 WAS MADE AS SHOWN HERE AFTER BAD PIPING WAS CUT OUT

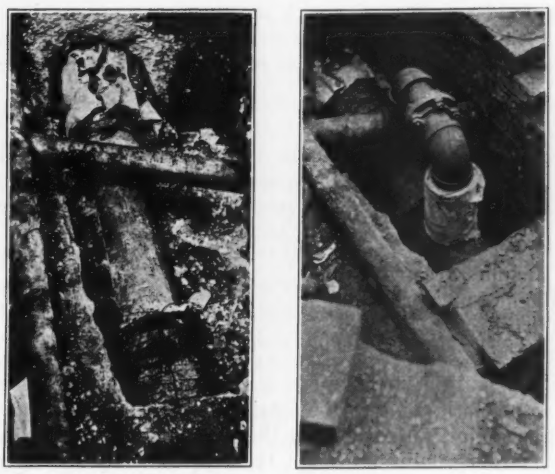


FIG. 4. DEFECTIVE PIPE AT CROSS OVER OF TWO SYSTEMS
FIG. 5. METHOD OF CONNECTING TWO SYSTEMS AFTER CUTTING OUT DEFECTIVE PORTION. WELD AT LEFT OF TEE

Rapid development of high pressure underground steam mains, as existing in all our large cities today, has been greatly influenced by the reliability of the butt welded joint. It has eliminated the necessity of burying fittings, flanges and coupling and has made

possible the use of higher temperatures and superheat with security.

To those who are still in doubt, as to the efficiency of a properly executed butt welded joint on a steel pipe, the following test will be convincing. Select two pieces of rather large diameter steel pipes; call in a competent welder and have the joint made, but insist that the edges of pipe be beveled. See that the weld is carried through to the inside circumference of the pipe, and that the outside surface of the weld is reinforced at least 10 per cent of the thickness of the pipe wall. Then have the welder cut some test bars 24 in. long by 3 in. wide, longitudinally along the pipe surface, so that the weld is located in the center of the bar. Insert this in a testing machine, with the clamps set reasonably close to the weld. The results of the test will be enlightening.

For example, the following figures illustrate what results have been secured from such tests as outlined above.

Cross Section Area of Test Bar = 1.584 sq. in.

Breaking Load = 78,340 lb.

The rupture in the foregoing test occurred in the pipe metal and at some distance from the weld, which remained undamaged. In other words, the weld was 100 per cent.

This procedure will give a clear insight to the character of welding done by the operator and assure desired results. If the rupture of the welded test bar occurs in the weld itself, it will usually be found due to the lack of penetration through the walls of the pipe, lack of sufficient reinforcing or burning of the metal. The inspection of the cross section of the rupture brings this out plainly. Care should be taken in the selection of the grade and character of the welding rod used.

Chemicals Effective as Condenser Tube Cleaners*

TESTS SHOW BOTH MECHANICAL AND CHEMICAL CLEANING METHODS EFFECTIVE, BUT CHEMICALS ARE PREFERABLE IN SEVERE CASES. OXIDE ON OUTSIDE OF TUBE PREVENTS ANY CLEANER FROM MAKING OLD TUBE AS EFFECTIVE AS NEW ONES. BY L. M. FORNCROOK

CAREFUL study of the scale found in condensers operating in different localities makes it apparent that the nature of the scale is so varied as to make it imperative to consider each type as a separate problem. If the best results are desired there is no cure-all for fouled condenser tubes and each case must be considered separately.

In any specific discussion the matter must be confined to one type of scale, in this case a very hard thin scale of a reddish tint with the chemical analysis shown in the table, the sole purpose of the analysis being to determine what chemical may be best used to attack the scale.

	Per Cent
Loss on ignition	27.38
Insoluble matter	29.58
Tar	10.94
Zinc	.26
Copper	.11
Calcium carbonate	13.89
Magnesium carbonate	1.97
Tin	.....
Sulphate (SO_4)	5.27

In addition to the scale mentioned, there was a coating of black oxide on the outside. The customary method of cleaning these tubes in the plant had been to shoot soft rubber plugs through them periodically by means of water pressure, a method which in this case proved to be inefficient because of the hardness of the scale. The tubes tested were about 19 ft. long, of 1 in. O.D., 18 B.w.g., Muntz metal, and had been removed from a condenser just prior to cleaning.

TUBES DO NOT HAVE SAME AMOUNT OF SCALE

Both mechanical and chemical methods were used in order to obtain a direct comparison. It is to be expected, and tests will show, that tubes, although taken from the same condenser, scale by slightly different amounts and therefore each scaled tube when tested will show a slightly different transfer rate. In applying different methods of cleaning it is necessary first to run a test to discover the transfer rate of the particular tube and then to compare the results on the basis of percentage increase of heat transfer due to that method rather than to compare the numerical rate obtained when cleaning by one method with that obtained when cleaning by another.

Scaling on the inside of the tube is not uniform, nor is the coating on the outside of the tube uniform inasmuch as tubes removed from different parts of the condenser are subject to slightly different conditions.

Heat transfer rates obtained at various velocities on the old tubes as received and simultaneous readings on the new tubes are shown by the curves on Fig. 1. The improvement obtained by shooting through one rubber plug is indicated as is the further improvement of following the rubber plug with a coil spring cleaner. The plug used in this case consisted of layers of canvas impregnated with rubber, a type which is much harder and, as tests have proved, much more efficient, at least in this case, than the usual type of soft rubber plug.

SOFT RUBBER PLUGS NOT AS EFFECTIVE AS HARDER ONES

Curves in Fig. 2 show results obtained on the second tube as received and the improvement in transfer rate obtained by using the same coil spring cleaner through the tube once without preceding it by the rubber plug. Only a slight improvement was obtained when the coil brush was run through the tube a number of times. It will be seen by observing Fig. 3 that the improvement gained from the soft rubber plug is only about 10 per cent as compared to almost 20 per cent using the harder type of canvas and rubber plug shown in Fig. 1. A third type of cleaner was very effective and when used six times showed no improvement over the first passage.

Tests carried on at the beginning of the experiment with chemical methods of cleaning these tubes are of interest. One of the scaled tubes as received was filled with a 5 per cent solution of hydrochloric acid at room temperature and allowed to stand for 2 hr. Transfer

*Abstracted from Powerfax, published by Elliott Co.

rates were then run, and the improvement is shown on Fig. 4. At the same time this test was run a small section from another scaled tube was immersed for a period of 2 hr. in a 5 per cent solution of hydrochloric acid, and at the end of about 20 min. the scale was completely removed by the acid. The tube appeared very bright, free from any sign of scale or coating on either the outside or the inside. At the end of 2 hr., nowever, the tube itself had been attacked by the acid and a reddish deposit of copper chloride covered both the inside and outside of the tube. This experiment indicated that a 5 per cent solution is entirely too strong for a 2 hr. treatment.

Coating on Outside of Tube Reduces Heat Transfer About 15 Per Cent

In order to determine the effects of the deposit of copper chloride, the tube was removed and the deposit cleaned out by inserting a rubber plug in the tube, followed by about one inch of tightly packed sand, then followed by another rubber plug, all three being blown through the tube several times in order to give it a good polish on the inside. Another test clearly illustrates the detriment to the heat transfer rate caused by the copper chloride deposit. This same tube was now carefully polished on the outside with an emery cloth and another test run which brought out the transfer rate up to the performance of a new tube.

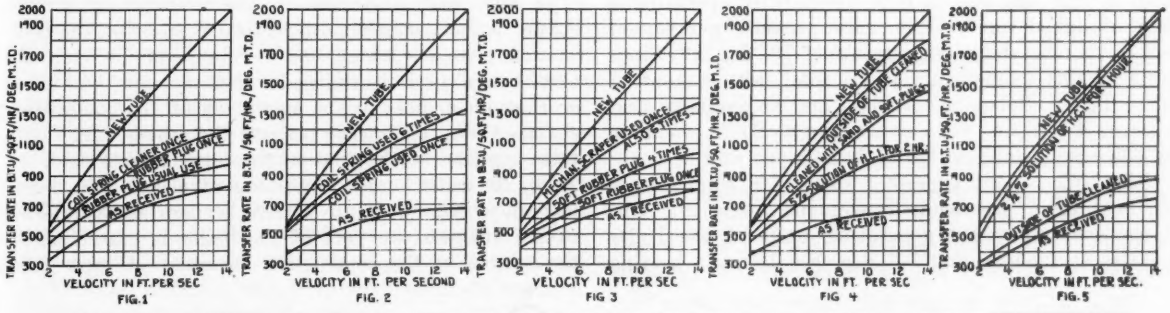
It is quite interesting to note that at a 6-ft. velocity, for example, the coating on the outside of the tube caused a decrease in the heat transfer of about 16 per cent, all of which indicates that any amount of cleaning on the inside of this tube could not bring its heat transfer rate to more than 85 per cent of the heat transfer rate obtained from a new tube at that velocity.

Laboratory experiments indicated that the proper concentration for this particular scale was a 2½ per cent solution by volume of hydrochloric acid for treatment of one hour duration. Tests further indicated that if it were more desirable either from the standpoint of economy or of time required to clean the condenser, a 1¼ per cent solution of acid could be used for two hour treatment, or 5 per cent solution for one-half hour's treatment.

Curves on Fig. 5 show surprising results obtained by treatment of one hour with a 2½ per cent solution of hydrochloric acid. The lower curve indicates the heat transfer of the tube as received. The tube was then cleaned on the outside with an emery cloth and the test repeated as a check against the previous one, and it will be seen as in Fig. 4 that at 6-ft. velocity outside coating of the tube is responsible for a decrease of approximately 16 per cent in the heat transfer rate.

Acid Cleaning Must Be Used with Care

In applying this method of acid cleaning to actual practice it is important that the tubes be first thoroughly water tested in order to avoid any possibility of getting acid in the condenser hotwell and subsequently into the boilers. As a further precaution it is well to allow longer periods of treatment in order to permit a correspondingly smaller acid concentration. So far as the effect of the acid on the tubes themselves is concerned, there is little cause for worry as laboratory experiments show that a section of clean Muntz tube, when immersed in a 2½ per cent solution of hydrochloric acid for one hour showed a loss of weight of only about 0.038 per cent. The same test applied to standard fiber packing showed the packing did not decrease in weight and did not deteriorate in any way so far as could be observed.



COMPARATIVE TESTS OF SEVERAL TUBE CLEANERS BRINGS OUT RELATIVE EFFECT OF DIFFERENT METHODS

Other tests on the same scale were conducted by circulating hot soda ash through the tubes. The soda ash did not attack the scale, instead the tube showed a slightly lower transfer rate after the treatment than it did before. Soda ash treatment, however, has been found in some cases to be very successful.

Acid methods of treatment in some cases are not only efficient, but cheap as well. The condenser from which these tubes were taken is a 20,000-sq. ft. unit holding 46,500 lb. of water. For one hour treatment it would be necessary to use 140 gal. of commercial hydrochloric acid which costs at the existing market price about $26. If it is desirable to use the two hour cleaning method the price would be cut in half.

After testing the tubes and filling the entire water space with water a central re-circulating pipe may be rigged up between the upper and lower pass of the condenser and a small jet of steam injected into the lower pass in order to secure slow circulation of the water. When this is accomplished the acid should be admitted slowly, to enable it properly to mix with the water.

When proper precautionary measures are taken this method of cleaning is not the least dangerous. In one plant where the scaling is unusually severe, acid treatment has proved to be the only known method of effective cleaning. The scale in this plant is soluble in about a 75 per cent solution of hydrochloric acid. One 23,500-sq. ft. condenser in this plant was cleaned at a

cost of approximately $3000, using 100 per cent pure acid, and the engineer in charge figures that he has saved considerable money for his company even with this unusually high cost of cleaning. Several condensate pump runners were ruined in the process and figured in the cost of cleaning the condenser. This is an example of one of the worst scale conditions possible, and is given in order to show the enormous expense which is justified in condenser tube cleaning where the scale conditions are unusual.

Much has been said and there is still much to be said on the question of cleaning surface condensers, but the present indications are for the majority of scale conditions that mechanical means will be employed for two or three cleanings and these cleanings may be followed periodically by a thorough chemical cleaning. Sometimes it is economical in some plants to re-tube the surface condensers every few years. The good tubes, of course, can be thoroughly cleaned outside and inside and replaced at a future date.

Boiler Operates Successfully at 1500 lb.

Possibilities of Higher Efficiencies and Greater Economies in Boiler Plant Operation Are Proved Possible in This German Development

DURING the last 10 yr. Sulzer Bros. in Winterthur, Switzerland, has built a number of boilers for pressures up to 480 lb. and in sizes to 14,000 sq. ft. heating surface. In order to secure greater safety and satisfaction in operation of boilers of still higher pressures without experimenting on its clients, Sulzer Bros. built about a year ago and is now successfully operating a boiler designed for 1565 lb. gage pressure per square inch and a total steam temperature of 707 deg. F. Since steam at this temperature has a total heat content of 1232.8 B.t.u. (Calendar's Tables) and an available heat value of 452 B.t.u. when expanding to 29 in. vacuum, the efficiency (Rankine cycle) is 38.1 per cent.

The boiler plant furnishes steam for manufacture and heating in practically continuous operation. One of the separate steam generating units of the boiler operates at 1565 lb. and 707 deg. F. It has a heating surface of 485 sq. ft. and a normal capacity of 7900 lb. per hr. The other unit, operating at 200 lb. and 662 deg. F., serves also as a feed-water heater for the high pressure unit. It has a heating surface of 1240 sq. ft. and a normal capacity of 4400 lb. per hr.

Powdered fuel is fired direct from high speed beater type unit coal pulverizers. The rectangular section burner is located in almost vertical position in the combustion chamber which has a volume of 1485 cu. ft. Combustion air is introduced either through the burner or through orifices in the side walls of the combustion chamber. An oil burner beneath the coal burner facilitates ignition of the coal when starting from cold. A 95-sq. ft. water screen consisting of eleven 3-in. seamless tubes expanded into square headers and connected to the low-pressure part of the boiler is placed across the bottom of the combustion chamber. Closed ducts

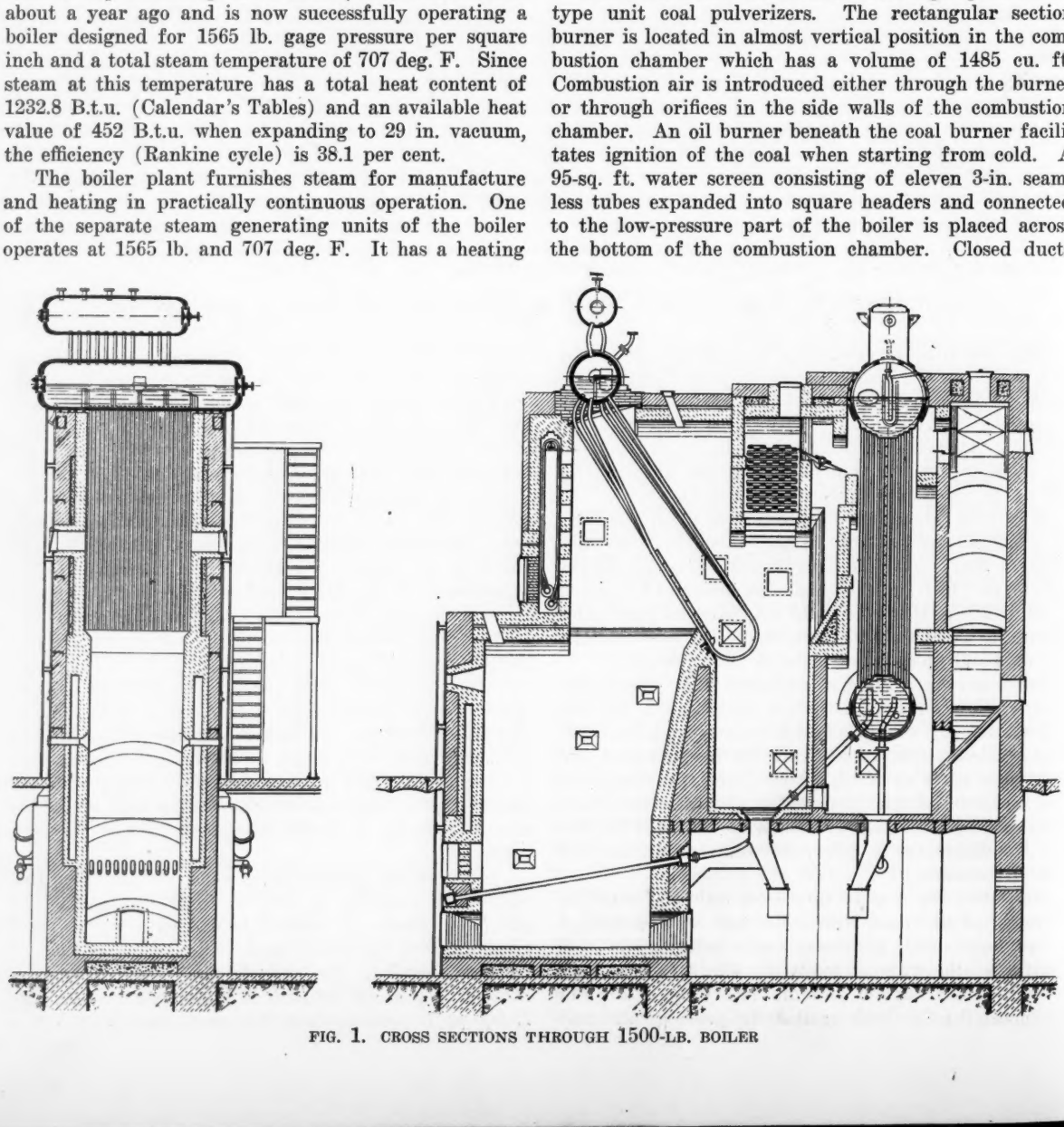


FIG. 1. CROSS SECTIONS THROUGH 1500-LB. BOILER

are located on the front and side walls through which cooling air circulates up and down several times; thence it passes into the air heater of 1940 sq. ft. area which is located back of the low pressure boiler. It is equipped with an induced draft fan.

In the high pressure boiler unit is an 86 sq. ft. radiant superheater; whereas the low pressure unit has a 430 sq. ft. superheater of usual construction located between the two boiler units, it may be bypassed if desired. The high pressure boiler unit consists of a seamless drum into which are placed the ends of the U-shaped heating tubes. A smaller drum or steam collector located above it is connected with it by a number of vertical tubes. These Krupp drums were forged from solid ingots, the ends being closed after the forgings had been machined inside and out. The material is 5 per cent nickel steel with an ultimate tensile strength of 30 to 37 t. per sq. in. and an elastic limit of 22 t. per sq. in. at 68 deg. F.

The 14-ft. high pressure drum has an inside diameter of 36 in., a thickness of 2.9 in., a thickness at the manhole of 4.6 in. and an approximate weight of 8.5 t. The steam collector has an inside diameter of 28 in., a thickness of 2.08 in., a thickness at the manhole of 3.35 in., a total length of 9 ft., 10 in. and a weight of 3.4 t.

There are 24 seamless high pressure water tubes with an outside diameter of 2.36 in. and a thickness of 0.276 in. with an average length of 42 ft. Both ends of each water tube are beaded into the high pressure drum. These seamless hot-rolled Mannesmann tubes are tested to 2845 lb. per sq. in. and have a tensile strength of 24 to 29 t. per sq. in. with a minimum elongation of about 20 per cent. The high pressure superheater tubes are of the same material and have an outside diameter of 0.138 in. and a thickness of 0.138 in.

In the high pressure boiler unit the normal rate of evaporation is 16.38 lb. per sq. ft. The high pressure tubes are exposed to intense radiant heat and are also in direct contact with the hottest gases from the furnace. Heat transmission is better, for the steam bubbles are smaller or fewer than in ordinary pressure boilers due to the smaller specific volume of steam. A smaller heating surface is therefore possible.

Raw water of 22 French degree hardness is treated in a Sulzer purifier and fed by means of a low pressure centrifugal pump against 206 lb. pressure into the low pressure boiler. The make-up feed for the high pressure boiler is about 5 per cent of the high pressure steam produced. A required amount of saturated steam passes from the low pressure boiler down into a preheater which has the form of a surface condenser. It condenses here and flows into the distilled water tank of 4400 (Brit.) gal. capacity. The water from this tank condenses the steam in the preheaters. Its bulk is the condensate from the high pressure steam after use. It is forced by a centrifugal pump working against 230 lb. per sq. in. through the degasser and the preheater to the suction side of the high pressure feed pumps. While passing through the preheater, its temperature increases to about 374 deg. F. at which it is fed to the high pressure boiler. Two high pressure boiler feed pumps, one steam driven, and one electric driven with an oil gear, are each capable of supplying the boiler at full load with adequate feed water at 1700 lb. per sq. in.

Heating steam passes from the high pressure boiler through a reducing valve to the steam collector and

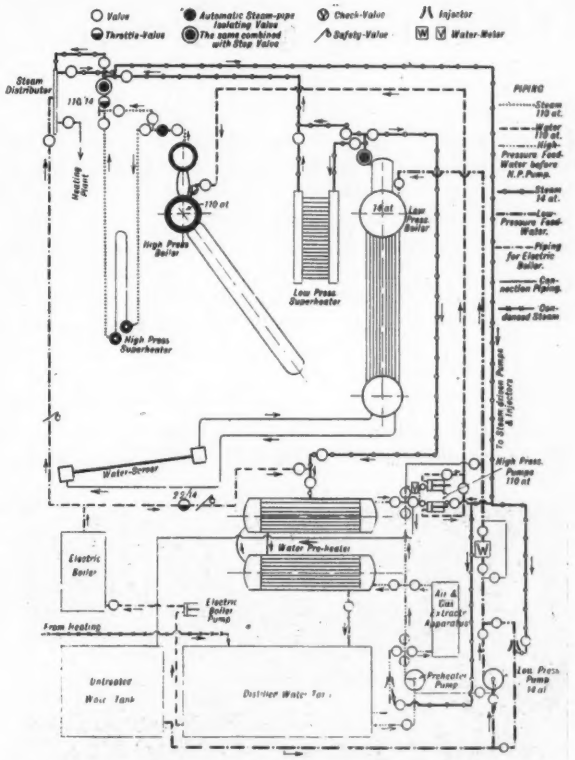


FIG. 2. DIAGRAMMATIC ARRANGEMENT OF 1500-LB. BOILER

thence into the steam heating system from which the condensate is returned to the distilled water tank.

On an 8-hr. night test run on Oct. 20, 1926, the pressure increased from 1280 lb. to 1350 lb., whereas in the 8-hr. night test run of Oct. 22 a constant pressure of 1565 lb. was maintained. In a series of 8-hr. tests and one 9-hr. test the pressure was increased in steps from 694 lb. to 1448 lb. and the rate of evaporation increased. The results showed that the new Sulzer boiler is fully equal to the results it is expected to give, and that the general design is perfectly satisfactory. For instance, on test No. 12 the results stand as follows: duration of test, 8 hr.; value of coal, 13,660 B.t.u.; coal per hr., 1386 lb.; average pressure of high pressure boiler, 1448 lb.; its water evaporation, 7357 lb. per hr., or 15.2 lb. per sq. ft.; (no superheater in this test);—the average pressure of the low pressure boiler, 188 lb.; its evaporation per hr., 4596 lb. per hr. or 3.56 lb.; temperature of its leaving gas, 617 deg. F.; temperature of its superheated steam, 567 deg. F.

Operation of a high pressure with a low pressure boiler thus avoids the installation of expensive high pressure heating surface in the region of low gas temperatures where the rate of heat transmission is low and large surfaces are therefore required. The large surfaces can be provided by the low pressure boiler without undue cost, whereas the high pressure boiler provides intensive heat absorption. The low-pressure boiler also provides distilled feed water at a high temperature for the high pressure boiler. Thus the high pressure boiler is protected from scale, is relieved from the work of warming water and preserved longer.

For the data contained in the foregoing article we are indebted to The Engineer of London, England.

Diesel Engines Prove Economical in Forge Plant

REPLACEMENT OF PURCHASED POWER SERVICE BY DIESEL ENGINE UNITS EFFECTS LARGE SAVING. USE OF PULVERIZED COAL ALSO DECREASES COSTS

IN DESCRIBING the important details of the power plant serving the Camden Forge Co. at Camden, N. J., it is necessary to explain briefly its history or rather that part of its history which dates back to the war period. At that time this plant, like hundreds of others, was working on a 24-hr. day, seven days per week schedule, and every mail brought more insistent demands for increased shipments. In attempting to meet the urgent demand for products it was found that the neck of the bottle was the power plant. Investigation indicated that the source of power had to be increased 300 to 400 per cent and this had to be done in a great hurry. This was no simple matter. Buying steam prime movers

FIG. 1. ONE OF THE THREE DIESEL ENGINE GENERATING UNITS INSTALLED AT THE CAMDEN FORGE CO. PLANT

was out of the question, due to the length of time required for delivery on both engines and boilers. The only alternative was to install conversion units and purchase power and this was finally done. Synchronous motor generator sets were installed for converting 2300-v., 2-phase, 60-cycle current to 230-v. direct. The conversion was necessary to fit the existing motor equipment throughout the plant.

The price of purchased power was based on the maximum demand in horsepower. This figure was a constant and was increased by the actual consumption in kw-hr.; the price based on a sliding scale dependent upon the amount used. This increased figure was further augmented by a surcharge of 25 per cent and an additional amount was added as a coal charge dependent upon the price of coal at the power station. From this total was allowed a 5 per cent discount for paying the power bills within 10 days after presentation. The result of these charges was an average power cost during the connection of $0.0273 per kw-hr. The lowest cost was $0.0183 per kw-hr. when the consumption was 288,000 kw-hr. and the highest was $0.1033 per kw-hr. when the consumption was 1500 kw-hr. These were direct charges and did not include depreciation or repairs on the conversion units or switchboard, nor interest on the capital investment. Furthermore, if no current was used, there was a "standby charge" amounting to 50 per cent of the maximum demand.

From these figures it is apparent that purchased power was rather expensive and the engineers in charge soon decided to cut loose from it, turning their attention toward the Diesel engine. Steam was also considered but, because of the lack of additional boiler space and excessive costs of engines and boilers, the Diesel engine was decided upon. Not only did this type of engine offer high economy but, being in the forge business and buying large quantities of oil for heating furnaces, it was unnecessary to increase the investment by the purchase of oil storage tanks and pumps.

Two Diesel engine generator sets were purchased having characteristics as follows: six cylinders, 2-cycle, low compression type, 300 brake hp. at 257 r.p.m., direct connected to 200-kw., 230-v., d.c. generators. The engines selected were built by the Fairbanks, Morse & Co. and known as their Y type. The generators were furnished by the Crocker-Wheeler Co.

Recently, a third Diesel generating unit has been added. This is also a Fairbanks-Morse unit, similar to the first two, but of the latest type and with a rating of 360 b.hp.

Among the reasons which determined these selections were: simplicity of design; few outside moving parts, and the fact that the units could be shipped as a whole, which lessened the erection time. The generators were selected to match the generator end of three automatic high speed steam engine generator units already installed.

Since their installation the operation of the Diesel units has been highly satisfactory. The first machine was started in June, 1923, the second in December of the same year. The third unit was installed about two years later, in July, 1925.

After the installation of the second machine a test was run on both units separately, with the following results:

Cost of power at the switchboard (direct charges only)	$0.0095 per kw-hr.
Cost of power at the switchboard (direct and indirect charges)	0.0189 per kw-hr.
Fuel consumption per kw-hr.	0.1385 gal. or 1.036 lb.

In the first figure of $0.0095 per kw-hr. the individual costs include fuel oil for operating at 4½c per gal., delivered to engine storage tanks, lubricating oil, kerosene for heating the starting torches, gasoline for operating the air compressor for starting, water and labor.

Two men are considered in the labor charge, the power house engineer, whose time is distributed over all the equipment in both the engine and boiler rooms, and an oiler whose time is distributed over the operation of the engine room equipment only. The direct and indirect charges of $0.0189 per kw-hr. also include interest at 6 per cent on the total investment, including engine, generator, air compressor and foundations; depreciation of 10 per cent on the cost of the equipment only, and repairs. The direct and indirect charges were separated to show a more exact comparison between the cost of Diesel engine produced power and public utility high tension power, converted; inasmuch as the direct charges

of the Diesel engine produced are comparable to the billed charges of the purchased, the indirect charges applying in both cases varying slightly with the cost of equipment in each instance. In other words, the $0.0095 is comparable to the $0.0273 mentioned in connection with the purchased power.

Steam Plant

Aside from the Diesel engine installations, the boiler plant supplying steam to the forge shops is also of considerable interest. As in all plants of this type, the steam load is highly fluctuating and it is difficult to operate at any particular rating for anything but a few minutes at a time. The load will vary from 75 per cent of normal rating to 125 and 175 per cent over short intervals of time.

As in the generation of electric power, in the steam plant also, the economy of operation has been noticeably improved during the past few years by the installation of modern equipment. The daily coal consumption has been cut from 44 tons to 33 tons using less help and the evaporation has been increased from 7½ lb. of water per lb. of coal to 9½ and 11. At the same time the CO_2 content of the flue gas has increased from slightly over 7½ per cent to 12 and 13 per cent.

Until about a year ago this plant consisted of 10 boilers, four return tubular units, hand fired, and six water tube boilers, stoker fired. No mechanical coal or ash handling equipment was installed, however, and considerable hand labor was involved in unloading and delivering the coal to the boilers. In the spring of 1925, however, it was decided to install a pulverized fuel burning system under two 550-hp. Edge Moor boilers, which were already installed and to provide a coal and ash handling system.

After some investigation the Kennedy-Van Saun unit system of pulverized coal burning equipment was selected as being the best suited for the particular needs at this plant. This equipment, which is provided for each of the two boilers, consists of a revolving feeder (upon which coal from the overhead bin is delivered), which delivers just the correct amount of coal to a horizontally revolving ball pulverizer. Coal fed into this cylinder is crushed and pulverized under the action of a number of hardened steel balls. An exhaust fan then removes the fine coal from the cylinder and forces it into the furnace.

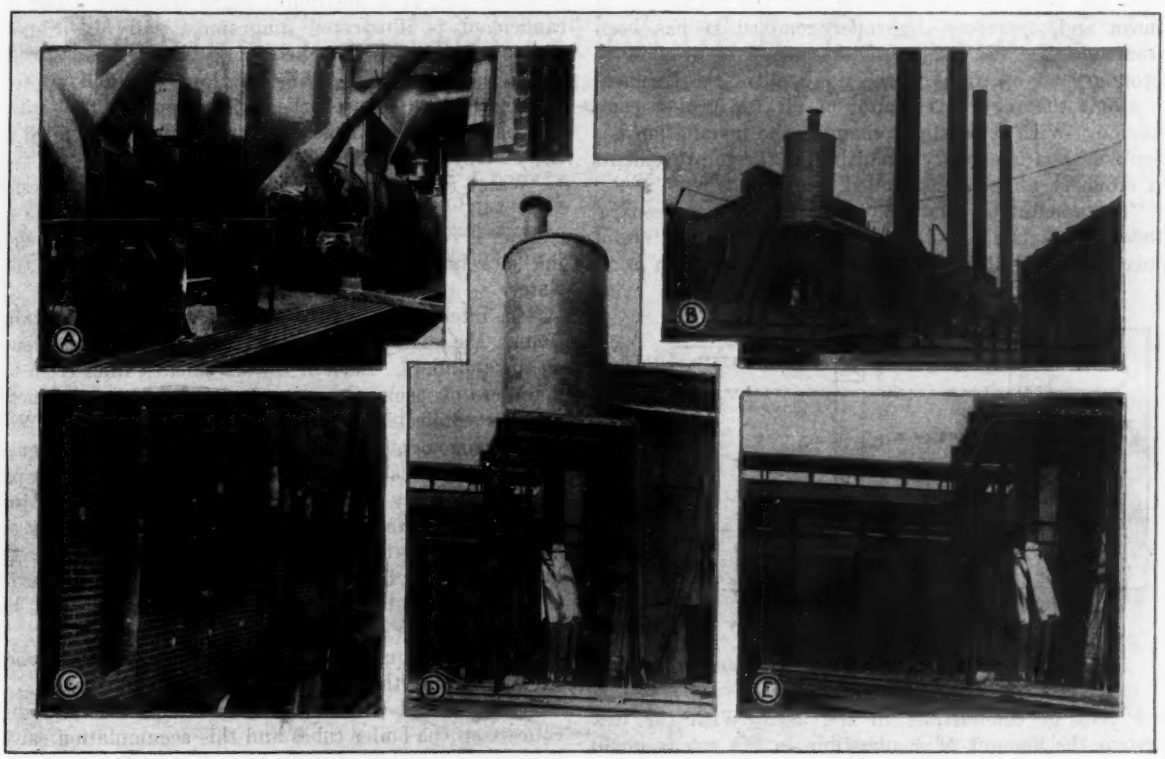


FIG. 2. VIEWS OF INTEREST AT THE CAMDEN FORGE PLANT

A. Unit pulverizers are installed in front of the boilers. B. An outside view of the boiler house. C. The boiler front, showing the pulverized coal burners. D. All ash is blown into this cylindrical tile ash tank. E. Coal not required for immediate use is stored in this coal bin. The conveyor is shown above.

Air for combustion is drawn in at the back of the furnaces through suitable ducts and after passing underneath the floor of the furnace, where heat is added, it issues from the front through a pipe and is sent into the pulverizing mill where the warm air evaporates the excess moisture in the coal. The same fan which forces the coal into the furnaces induces the necessary suction to draw the air through the furnace. The air attains a temperature of about 400 deg. in passing underneath the furnace but, as it enters the pulverizer, this drops to about 350 deg.

The pulverizing equipment is operated by three electric motors; one 50-hp. motor for driving the pulverizing mill; one 15-hp. motor for operating the fan; and a third, ½-hp. motor for operating the coal feeder.

This system has been found satisfactory and beyond the usual minor troubles which accompany the starting of any new mechanical equipment, particularly anything so new in the field as pulverized coal apparatus, no serious difficulty has been experienced.

Since the Edge Moor boilers were originally stoker fired, in order to avoid the necessity of raising the boilers, the furnaces were dug out. When first installed, however, the burners were set too high in the front wall and trouble was had with excessive smoke. To overcome this the burners were lowered to remove the flame from the boiler tubes and since then the formation of smoke and, therefore, improper combustion has been overcome. It was also found necessary to provide 16 secondary air openings in the side wall of the furnaces to admit the required amount of air for proper combustion. With these slight changes, the installation has performed satisfactorily, resulting in the improvements in economy already mentioned.

The amount of combustible in the ash has been reduced to practically nothing. Before the installation of pulverized fuel, it was customary to have as much as 20

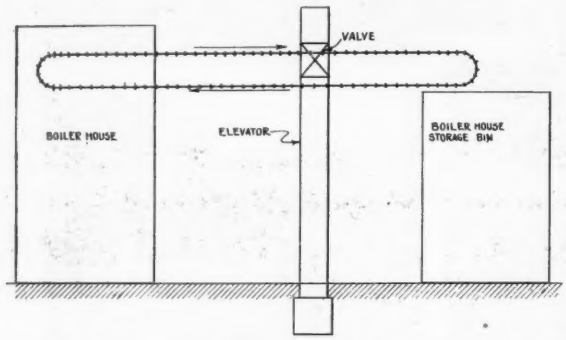


FIG. 3. DIAGRAM OF THE HANDLING EQUIPMENT

per cent of combustible in the ash. With the new system the amount of combustible in the ash is about ½ of 1 per cent. It is realized, however, that a certain amount of ash is lost up the stack so the actual amount of unburned coal is probably greater than that recovered in the ash. The amount of ashes to be removed is also less than before. A considerable amount of ash collects on the boiler tubes during normal operation. This is blown off at intervals by the Diamond soot blowers with which each boiler is fitted and is discharged up the stack.

Ash is removed from the furnaces manually and hoed into the intake openings of a United Conveyors Corp. steam jet ash conveyor which has been installed along the front of the boilers. This is then blown into a cylindrical, tile ash tank, supported on a steel framework just outside of the boiler room.

The construction of this tank is of interest. It is supported upon a steel structure, as shown in Fig. 2D. The floor and roof are constructed of hollow tile laid between I-beams and completely covered with cement. The sides are built up of circular hollow tile, 12 in. square by 6 in. in thickness and each course of tile is reinforced by steel banks imbedded in concrete. The tile used is a hard vitrified clay product glazed on all sides, is impervious to heat or cold and never requires painting.

Ash stored in this tank is discharged by gravity from the bottom of the tank into trucks below.

Coal Handling

The coal handling equipment is also new. Coal delivered to the plant in railroad cars is introduced into a receiving track hopper and, by means of a short apron conveyor, is fed to a crusher which reduces it to the proper size for the pulverizing mill. From the crusher it is carried upward by a vertical, centrifugal discharge elevator which delivers either to the upper or lower run of a horizontal flight conveyor. The arrangement is illustrated diagrammatically in Fig. 3. The lower flight carries the coal to the overhead storage bin in the boiler room, while the upper one delivers to a storage bin outside of the boiler house. The entire coal handling equipment was furnished and installed by the Jeffrey Mfg. Co.

Water for all purposes is obtained from an artesian deep well. It is not treated. Waste heat from the oil engines is reclaimed by passing the water from the cooling jackets on the oil engines into the boilers as feed water.

An interesting feature of the Diesel engine installation is the method employed for equalizing the loads on the cylinders. Each of the six exhaust lines from the cylinders on each oil engine is fitted with a pyrometer element connected to an indicating pyrometer. With this arrangement the temperatures of the exhaust gases from the various cylinders can be compared. If, upon comparing these temperatures, any wide temperature difference is noted, the fuel valves on the cylinders are adjusted until the temperatures and, therefore, the loads on the cylinders have been equalized. This arrangement has been found extremely useful and has eliminated some slight difficulty with carbon.

A similar equipment is installed in the boiler room for indicating the condition of the boiler tubes. As has been stated previously, considerable ash and dust collects on the boiler tubes and this accumulation causes the flue gas temperature to rise from 490 deg. (when the tubes have just been cleaned) to about 600 deg.

A pyrometer element is installed in the breeching just outside the damper which is connected to an indicating instrument. By watching this pyrometer it is a simple matter to determine when the soot blowers should be operated.

These improvements have all been carried out under the direction of J. P. Harbeson, Jr., chief engineer of the Camden Forge Co., to whom we are indebted for the information contained in this article.

Under sea lighting has been used to some extent for taking moving pictures and recently for salvaging wrecked vessels. Great water pressures and salt water corrosion are being overcome by glass housings and special insulation so that it is predicted that use of such lighting will become common for salvaging, for scientific study of the sea bottom and for lighting bathing beaches.

An Illinois producer of seed corn, in order to test for disease, built an insulated germination box, which was heated by electricity and also had temperature control. He found this equipment the most satisfactory ever used in testing his seed corn.

ELECTRICAL MACHINERY FOR LIGHT AND POWER

Voltage Standardization of A. C. Systems

A Discussion of the Present Situation and of the Proposed Standards, as Viewed by the Electrical Manufacturers. By F. C. Hanker[1] and H. R. Summerhays[2]

PROGRESS IN THE voltage standardization of the complete a.c. electrical system has been largely a matter of the standardization of the several divisions of apparatus rather than a concerted standardization of the whole operating system. High voltage standardization dates back to 1899, when the standardization rules of the A. I. E. E. recommended that the rated circuit voltage should be measured at the receiving end and that the recommended values should be 1000, 2000, 3000, 6000, 10,000, 15,000 and 20,000 v. In order to take care of line drop, generators were to be rated at 1150, 2300 and 3450 v., thus allowing a total transmission regulation of 15 per cent. The 1911 standardization rules made a sweeping revision in that it was decided to measure the circuit voltage at the sending end. The recommended voltages were no longer based on multiples of 10 but on multiples of 11 and the list was extended to include 88,000 and 110,000 v. It was also recommended that transformers should transform between the listed voltages and that their ratios should be exact multiples of five.

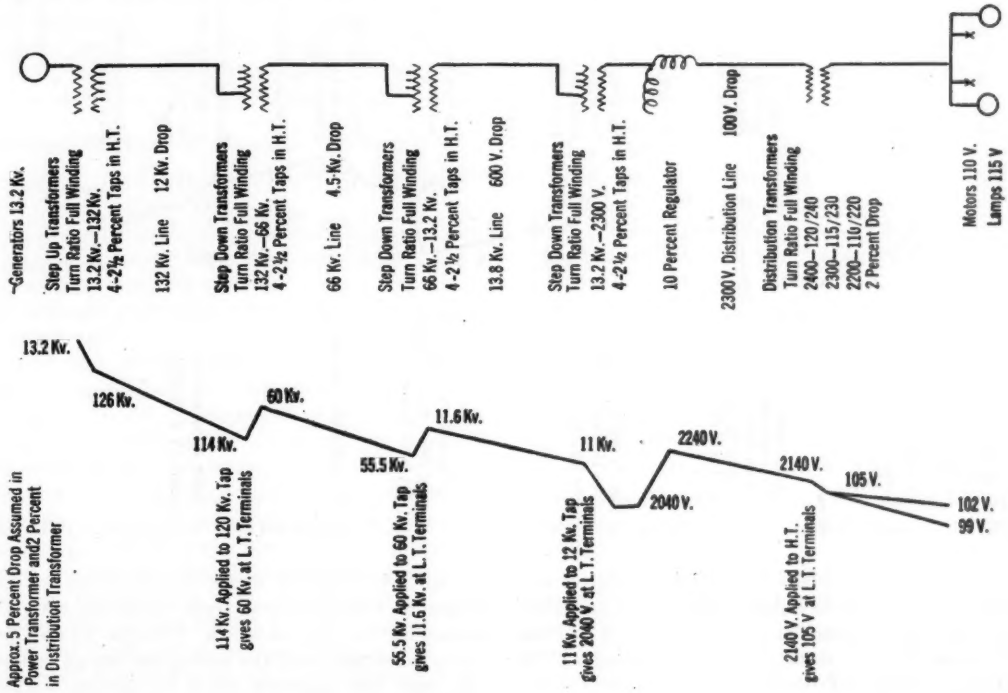


FIG. 1. TRANSMISSION AND DISTRIBUTION CONNECTION AND VOLTAGE CHART—OLD STANDARD VOLTAGES—FULL LOAD

In 1914 motor voltages became standardized at 110, 220, 440, 550 and 2200 v., the machines being designed for a 10 per cent variation above or below rated voltage. Standardization of lamp voltages came later. With the development of the Tungsten filament lamp the operating companies were urged to adopt whichever of three proposed lamp standards, 110, 115 or 120 v., was best suited to their needs.

At the present time, however, the trend is quite definitely toward the use of 115-v. lamps with the 120-v. lamp a close second.

In the field of electric heating, the tendency has been to express the voltage rating of the appliance in terms of a voltage range rather than as a definite volt-

*Abstract of a paper presented at the Winter Convention of the A. I. E. E., New York, Feb. 7-11, 1927.

[1]Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

[2]General Electric Co., Schenectady, N. Y.

age. Examples of this method of rating are 100-114, 105-115, 111-120 and 115-120 v. taken from the nameplates of well known appliances. This short list serves to indicate that little standardization has been attempted among the appliance manufacturers.

The foregoing reviews briefly the situation which has developed with respect to utilization voltages during the past 10 or 15 yr.

In the interest of standardization an investigation of service voltages was conducted in 1920 by the N. E. L. A. Subcommittee on Standardization and in 1921 and 1922 reports of the N. E. L. A. Electrical Apparatus Committee it was tentatively recommended that the standard service voltage be such that the proper average voltage would be supplied to 115-v. lamps, with recognized departures for supplying the proper average voltage to 110 and 120-v. lamps.

age feature implied that at times the impressed voltage might be 2 or 3 v. above 120 and thus exceed the 10 per cent tolerance allowed in the electric power club rules.

Answers to Questionnaire Show Deficiencies of Present Standards

It was recognized that the standardization of service voltage would be possible and of value only if it could be co-ordinated with the rest of the system all the way back to the generator. Accordingly, the final disposition of the Subcommittee report was that it was recommended in 1923 to be brought to the joint attention of the A. I. E. E., Electric Power Club and N. E. L. A. with the idea that these agencies might co-operate in the future towards voltage standardization of the electrical system from the generator to the utilization device.

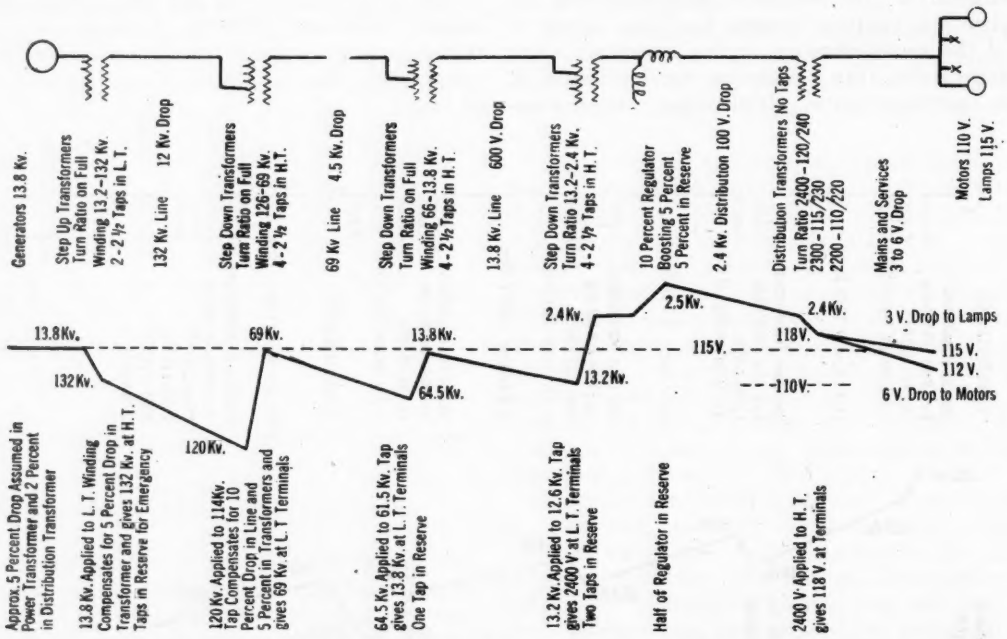

Generators 13.8 Kv.
Step Up Transformers Turn Ratio on Full Winding 13.2–132 Kv. 2-2½ Taps in L.T.
132 Kv. Line
12 Kv. Drop
Step Down Transformers Turn Ratio on Full Winding 126–69 Kv. 4-2½ Taps in H.T.
69 Kv. Line
4.5 Kv. Drop
Step Down Transformers Turn Ratio on Full Winding 66–13.8 Kv. 4-2½ Taps in H.T.
13.8 Kv. Line
600 V. Drop
Step Down Transformers Turn Ratio 13.2–2.4 Kv. 4-2½ Taps in H.T.
10 Percent Regulator Boosting 5 Percent 5 Percent in Reserve
2.4 Kv. Distribution 100 V. Drop
Distribution Transformers No Taps Turn Ratio 2400–120/240 2300–115/230 2200–110/220
Mains and Services 3 to 6 V. Drop
Motors 110 V. Lamps 115 V.
13.8Kv.
132Kv.
120Kv.
69Kv.
64.5Kv.
13.8Kv.
2.4Kv.
13.2Kv.
2.5Kv.
115V.
110V.
2.4Kv.
118V.
3 V. Drop to Lamps
115 V.
112 V.
6 V. Drop to Motors
Approx. 5 Percent Drop Assumed in Power Transformer and 2 Percent in Distribution Transformer
13.8 Kv. Applied to L. T. Winding Compensates for 5 Percent Drop in Transformer and gives 132 Kv. at H. T. Taps in Reserve for Emergency
120 Kv. Applied to 114Kv. Tap Compensates for 10 Percent Drop in Line and 5 Percent in Transformers and gives 69 Kv. at L. T. Terminals
64.5 Kv. Applied to 61.5 Kv. Tap gives 13.8 Kv. at L. T. Terminals One Tap in Reserve
13.2 Kv. Applied to 12.6 Kv. Tap gives 2400 V at L. T. Terminals Two Taps in Reserve
Half of Regulator in Reserve
2400 V Applied to H. T. gives 118 V. at Terminals

FIG. 2. TRANSMISSION AND DISTRIBUTION CONNECTIONS AND VOLTAGE CHART—NEW PLAN—FULL LOAD

The "recognized departure" of service voltages corresponding to 110 v. at the lamp socket was admitted due to the number of companies that could not increase their delivered service voltage without exceeding the safe operating voltage of their generators; and the recognized departure of service voltage corresponding to 120 v. at the lamp socket was admitted due to the number of companies that felt they could not reduce their service voltage without losing considerable revenue on account of reduced voltage running of lamps.

This scheme fitted in fairly well with existing distribution transformer voltages, except that on systems requiring 120 v. at the lamp socket, the voltage at the transformer secondary must be between 123 and 124 v. to allow for the drop between transformer and lamp, and hence the excitation voltage impressed on the primary must be on the order of 2500 v. This would work the iron rather heavily. There was also some question raised as to the successful operation of 110-v. motors when the average service voltage was such that the average impressed voltage was 120, since this aver-

In an investigation which followed replies to a questionnaire were received from 22 power companies, representing the two cases: a. Systems where the feeders were fed directly off the generator bus at generator voltage, and the stepping down to service voltage accomplished through two or more transformations, and b, systems where transmission at high voltage intervenes between the generator bus and the distribution system.

Eleven of the 22 companies had transformers on their systems over-excited by more than 5 per cent above the connected tap rating. In five cases this over-induction was 10 per cent or more above the connected tap rating.

Three companies reported their generators to be operating at more than 5 per cent above their normal rating, the maximum being 9 per cent above normal. Thirteen of the remaining companies operate their generators above normal, but not more than 5 per cent above the normal voltage rating.

Whereas feeder induction voltage regulators were required to operate at greater buck than boost in five

cases in order to maintain satisfactory service voltage, and to operate at equal buck and boost in seven cases, there were twelve cases where they were required to operate at greater boost than buck.

The evidence was plain that the existing voltage standards did not allow the maintaining of voltage at the point of utilization under load conditions unless the voltage at the various generation and transformation points was maintained above normal. The reason for this was that the existing transformer voltage standards did not compensate for the line drop in transmission line and feeders.

To remedy this situation, action was commenced for making a very complete presentation of the entire problem to the industry as a whole in order that concerted and general action might result after all interested parties had been thoroughly informed and afforded ample opportunity for presenting their views. The broadest vehicle for this presentation was considered to be a group of papers submitted before a convention of the American Institute of Electrical Engineers, these papers to be prepared by representatives of the operating companies, holding companies, consulting engineers, European engineers and the manufacturers. This present paper is based on a memorandum which resulted from the co-operative action of the manufacturers.

Proposed System of Voltage Standards

The proposed standards were drawn up to meet the following five conditions:

a. The new standards must provide apparatus capable of meeting most of the service requirements of a well designed and operated system.

b. The voltages selected must closely resemble those now in use to permit a reasonable degree of interchangeability of new and old apparatus.

c. The changes involved must not necessitate too great an expense in the development of new apparatus.

d. Admittedly, universality of use is an essential end to be sought in all standardization.

e. The new standards must provide apparatus that will meet in spirit as well as in letter, all requirements as set forth in the standards of the American Institute of Electrical Engineers. The apparatus should not only be capable of meeting the test requirements of the A. I. E. E. standards, but should readily lend itself to operation within the limits as defined by them.

As individual pieces of apparatus are interconnected electrically to form any operative system, it is incumbent upon the designers to determine the maximum voltage at which the system will be normally operated and to be certain that this will not materially exceed the accepted factors of safety for the individual pieces of apparatus of which it is composed. At present the most important rule in the A. I. E. E. standards defining "Rated Circuit Voltage" appears in the transformer section. It has been suggested in the Standards Committee to issue a new general rule resembling the present one, reading substantially as follows:

Rated Circuit Voltage. For the purpose of fixing a value to be used in designing and testing electrical apparatus, the rated voltage of a circuit or system is defined as the highest rated voltage of the apparatus supplying it. By circuit voltage is meant the voltage from line to line as distinguished from line to neutral. This voltage rating applies to all parts of the circuit. The actual operating voltage of the circuit may vary from the rated circuit but should not exceed it.

The present voltage standards, excepting apparatus rated at 2300 v. and below, call for apparatus whose voltage ratings are expressed in even multiples of 11. These voltages apply to motors transformers, both primary and secondary windings, and generators, with the exception that in some cases transformers are given a double rating. A simple system employing the present voltage standard is shown in Fig. 1.

In this elementary but representative system, the voltage ratings of generators, motors, and step-up and step-down transformers are shown as multiples of 11, excepting that the substation transformers supplying the the 2300 v. distribution lines are rated at 2300 v. and the distribution transformers are given the usual triple rating of 2400-2300-2200 v.

The voltage drops assumed are as follows:

132-kv. line	10	per cent approx.
66-kv. line	7½	per cent approx.
13.2 kv. line	5	per cent approx.
2300-v. line	5	per cent approx.
230-115 mains	3	per cent to lamps
and services	6	per cent to motors
Power transformers	5	per cent
Distribution transformers	2	per cent

This diagram shows that with the generator operated at rated voltage the voltage at the 115-v. lamps would be only 102 v. at full load on the system, and the voltage at motors 10 per cent low, even if transformer is operated on its lowest high tension tap and a regulator boosting 10 per cent is allowed for. The alternative at present is to over-excite the generating end of the system. It is this that is now so commonly done. If we assume motor and lamp voltages as fixed, it would seem obvious that the principal faults with the present systems are that transformer ratios are too high and generator potentials too low.

Features of Proposed Standards

The new system of standard voltages here proposed contemplates a change in the principle of the present system. An example of the new system is shown in Fig. 2. Here, as in the present system, step down transformers will be equipped with the equivalent of four 2½ per cent taps in the primary windings below rated voltage. Step up transformers for location adjacent to generators will be equipped with the equivalent of two 2½ per cent taps in the primary windings below rated voltage to provide additional range for compensating for the voltage regulation of the transformers and to avoid over-excitation of the generators. With this standardization the deficiencies of the present standards have been eliminated. The actual voltage values which it is proposed to assign to the several voltage classes are shown in the accompanying tabulation. They are admittedly a compromise with the present standards. The motor voltages now in use have been retained. In the lower voltage range generator voltages will not be changed. In the upper they will be increased approximately 5 per cent. Step down transformers having primaries rated 2300 v., in which class fall the millions of kv.a. capacity now in use for lighting service, will not be changed.

By the definitions previously quoted, the rated sys-

tem voltage becomes the rated voltage of the generators or secondaries of the transformers supplying the system. It will be noted that above 4150 v. recommended system voltages are approximately multiples of 11.5 up to and including 69,000 v. Above they are multiples of 11. This is a compromise based on a study of existing systems and the cost involved in changing manufacturers' present designs. There are so many step-down transformers in the 66,000 v. class and below whose primaries are multiples of 11 that it was thought inadvisable to change their voltage ratings and it was necessary therefore to increase the system voltage ratings and step up transformer secondary voltages for those classes to multiples of 11.5. The low tension windings of the transformers will be rated five per cent lower than the system voltages or generator voltages.

Thus, step up and step down transformers will not be interchangeable, but each will have the proper ratio for its purpose. To make them interchangeable would require 25 per cent range, which would involve too great an expense if applied to all transformers. Transformers of 25 per cent range may be required in many cases where power flows in either direction, but such transformers should be of special design in which extra cost should not involve the whole line of transformers. The tabulation of voltages gives also the present manufacturers' standards for apparatus voltages, such as oil circuit breakers, disconnecting switches, etc. These standards for 88,000 v. and above correspond to the system voltages of multiples of 11. Below 88,000 v. they are somewhat higher than the recognized system voltages given in the tabulation in order to meet existing conditions in the lower voltages. The tabulation also gives motor voltages in multiples of 11 while the generator voltages, in order to allow for line drops are multiples of 12 up to 2400 v. and multiples of 11.5 from 6900 v. up.

It is believed that the plan set forth here will fulfill the five conditions set forth in earlier paragraphs and furnish an escape from the present embarrassing dilemma and it is hoped that those interested in this question of a.c. voltage standards will accept and consider this proposal in the spirit in which it is offered, namely, simply as a basis of discussion, as a seriously and comprehensively thought out plan of voltage standards for all apparatus employed in transmission systems. It will fully serve its purpose should it lead ultimately to a rational set of standards which can be employed with a reasonable degree of success in new systems and throughout an appreciable part of existing ones.

It is expected that the adoption of these proposed standards will eliminate the use of apparatus which is special with respect to voltage and would therefore help remedy a situation which has cost the public from $100,000,000 to $200,000,000.

PROPOSED VOLTAGE RATINGS FOR SYSTEMS, GENERATORS, SWITCHING, CONTROL AND PROTECTIVE APPARATUS, TRANSFORMERS, ETC.

Systems	Generators and syn. condensers (see "A")	Induction motors (see "B")	Apparatus (see "C" and "D")	Step-up transformers		Step-down transformers	
				Primary (see "E")	Secondary (see "E")	Primary (see "E")	Secondary (see "E")
	120	110					115
	240	220					230
	480	440					460
	600	550					575
2,400	2,400	2,200		2,300/3,980 Y	2,400/4,150 Y	2,300/3,980 Y	2,400/4,150 Y
4,150	4,150	3,800					
6,900	6,900	6,600	7,500	6,600	6,900	6,600	6,900
11,500 (F)	11,500	11,000		11,000	11,500	11,000	11,500
13,800	13,800	13,200	15,000	13,200	13,800	13,200	13,800
23,000			25,000	22,000	23,000	22,000	23,000
34,000			37,000	33,000	34,500	33,000	34,500
46,000			50,000	44,000	46,000	44,000	46,000
69,000			73,000	66,000	69,000	66,000	69,000
88,000			88,000	84,000	88,000	84,000	88,000
110,000			110,000	105,000	110,000	105,000	110,000
132,000			132,000	126,000	132,000	126,000	132,000
154,000			154,000	147,000	154,000	147,000	154,000
220,000			220,000		220,000	210,000	

GENERAL NOTE

Guarantees of efficiency, heating, overload, etc., and over-voltage tests of all apparatus should be based on the rated voltage of the apparatus with the exception of step-down transformers, the over-voltage tests on which should be based on rated secondary voltage; and a primary voltage five per cent greater than rated voltage.

SPECIFIC NOTES

"A"—Generators and synchronous condensers should be designed to deliver rated kv-a. output at rated power factor and frequency throughout a range of five per cent below to five per cent above rated voltage.

"B"—Induction motors should be designed to deliver rated h. p. throughout a range of 10 per cent below to 10 per cent above rated voltage at rated frequency.

"C"—Apparatus, as here used, includes oil circuit breakers, disconnecting switches, current transformers, insulators, bushings and fuses. The voltage ratings of potential transformers should be the same as the recommended system voltage ratings; their secondaries should be rated approximately 115 volts to permit the employment of the now existing even ratios of transformation. Above 73,000 volts, apparatus should be designed to operate successfully at five per cent above rated voltage during emergencies. Up to and including 73,000 volts, apparatus is maximum rated. For maximum rated apparatus the operating voltage of the system on which it is used should not exceed the rated voltage of the apparatus even during emergency operation.

"D"—Lightning arrester voltage standardization recommendations have been omitted pending further study.

"E"—Transformers should be designed to operate during emergencies at five per cent above rated voltage, the over-voltage being obtained by over-excitation and not through the use of taps. They should be equipped with taps as follows:

(a) Step-up transformers should be equipped with the equivalent of two 2½-per cent full capacity taps in the primary windings to provide additional range for compensating for the voltage regulation of the transformers and to avoid over-excitation of generators.

(b) Step-down transformers should be equipped with the equivalent of four 2½-per cent full capacity taps in the primary windings to provide additional range for compensating for line voltage drop.

"F"—When possible, 11,500-volt systems should be discouraged in favor of 13,800-volt ones.

Electric Power for the Movies

New First National Studios at Burbank, Cal., Have Interesting Electrical Layout

WITH THE STARTING of the motor generators in the studios of the First National Productions Corporation at Burbank, California, one of the largest film cities in the world recently went into production. These studios, designed and constructed by the Austin Co. of California, comprise some 30 large buildings. An elaborate electrical system is installed which is designed not only to satisfy present needs, but also has ample provision to fulfill the requirements of buildings to be erected in the future.

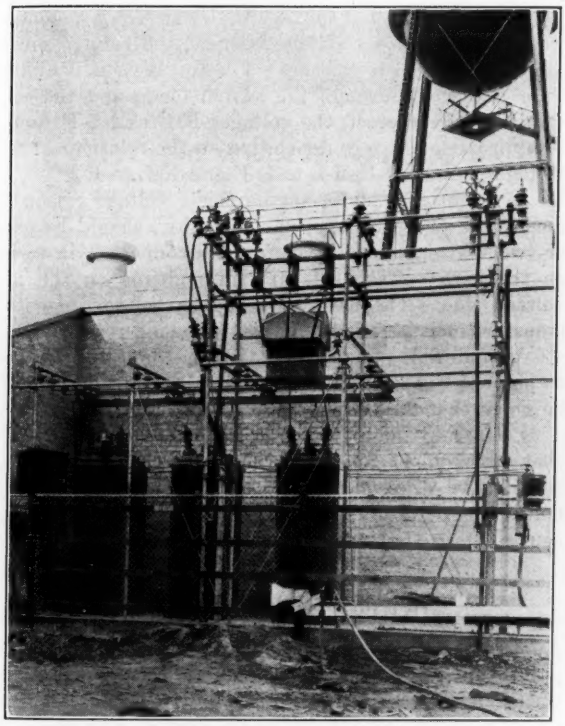


FIG. 1. TRANSFORMER BANK CONSISTING OF THREE 500-KV.A., 15,000/2300-V. UNITS, INSTALLED JUST OUTSIDE THE GENERATOR ROOM

All electrical energy is supplied by the Southern California Edison Co. over two separate 15-kv., 3-phase, 50-cycle lines, run underground from the property line to a transformer platform just outside the generator room which is approximately in the center of the yard. These lines terminate on a double-throw switch, then to a bank of three 500-kv.a. transformers through an oil circuit breaker. This transformer platform, which is shown in Fig. 1, has been made sufficiently large to permit the installation of an additional bank of three 500-kv.a. transformers, and the bus work is arranged so that it may be readily extended. From the 2300-v. secondary bus a line is carried to the alternating current switchboard in the generator room. The a.c. switchboard and the entire secondary distribution system, including transformers, will operate at 2300 v. for the present but all equipment is insulated for 5000 v. or designed to operate at 4400 v., so that it may be changed to a 4000 or 4400-v. system without additional expense.

Present generating equipment consists of three 300-kw., 3-unit motor generator sets, each set consisting of one 450-hp. synchronous motor direct connected to, and mounted on a common bed plate with two direct current generators, rated at 150 kw., 125 v. each. The generators are guaranteed not to vary over 3 v. from no load to 150 per cent load, and are connected in series to supply three-wire service of 250/125 v. In addition to these stationary motor-generator sets, there will be two 250-kw. sets of a similar type, mounted on trucks for portable uses. These may be set at points of heavy load around the yard or taken out on location where 2200 or 4000-v. service is available, or they may be paralleled with the stationary sets in the generator room.

FIG. 2. A VIEW IN ONE OF THE MILL BUILDINGS AT THE FIRST NATIONAL STUDIOS

The a.c. control board consists of 12 panels, 3 of which are synchronous motor starting panels; 2 feeder panels; one incoming main line panel and 6 feeder panels. The auto starters for the synchronous motors are installed in a vault underneath the a.c. switchboard.

The d.c. switchboard consists of 6 main generator control panels, 12 feeder panels and 2 tie panels, the latter two serving to parallel the portable motor generator sets to the d.c. bus. The 12 feeder panels control three 3-wire feeders to each of four stages, each feeder being made up of two 500,000-c.m. cables on the outside legs, and one 500,000-c.m. cable for the neutral. A double bus system with double throw switches on all panels is used, which permits a very flexible operation.

Ample space has been provided in the generator room for the addition of 1500 kw. of motor generator sets, and the necessary control panels as well as additional feeder panels for future stages.

The d.c. wiring in each of the four present stages, which are 135 ft. wide, 240 ft. long and 35 ft. high, consists of three feeders of the same size as described above running the entire length of the stage 5 ft. above

the bottom chord of the trusses, each feeder being tapped for four 600-amp. switches spaced equally along the length of the stage; these switches are 2-pole, single throw, and are equipped with 3 clamping bars for stage cable connections.

General illumination in the stages is provided by 300-watt lamps in steel enameled reflectors, and is figured on the basis of 1 watt per sq. ft. of floor area. Each of four stages now completed have a floor area of approximately 35,000 sq. ft. The 137-ft. trusses for these stages were especially designed by the Austin Co. to support the heavy stationary and portable lamps, each truss being required to support a hanging load of 12,000 lb.

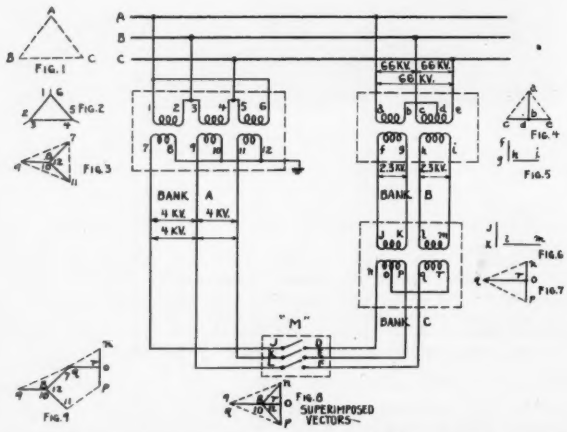
There are above 200 hp. of shop and mill motors in the buildings at the south end of the yard which are supplied with energy through a 220-v. secondary distribution system from a bank of 2200/4400-v./220/110-v. transformers in a vault in the mill building, the lighting in all the shops buildings is based on 1 watt per square foot of floor area, using steel enameled reflectors.

There is another transformer bank at the north end of the yard for supplying 220/110-v. light and 220-v., 3-phase power in the administration portion of the yard.

Interconnection Between Two and Three-Phase Circuits

By C. O. Von Dannenberg

IN THE DEVELOPMENT of low voltage distribution circuits, the general trend appears to be tending mainly in the direction of three phase, four wire systems.



THREE-PHASE-TWO-PHASE TRANSFORMATION WITH INTERCONNECTION BETWEEN CIRCUITS

It is not uncommon to find many systems in which two-phase circuits, three wire and four wire, were originally installed so that in changing over to a three-phase system, either three or four wire, it is necessary at times to interconnect two-phase and three-phase circuits during some period while the changes are being made.

Accompanying are a number of diagrams showing connections that were necessary in an actual distribution system to conform to the operating conditions mentioned in the foregoing paragraph. These conditions briefly are as follows: Transformer banks "A" and "B" are fed from the same high voltage system at points some distance apart and in turn feed different sections of the same city. It became advisable to connect the 4-kv., three-phase circuit to a portion of the two-phase system at point "M"; to do this it was necessary to install transformer bank "C" for this purpose.

The windings of the transformers are numbered at the end of each high voltage and low voltage phase end. Figures 1 to 8 inclusive show vectorially the voltage relations for each circuit and Fig. 8 particularly shows the voltage relations of the super-imposed vectors of Figs. 3 and 7 at the junction point "M."

The actual test for the correctness of the connections at point "M" was made by closing one of the disconnecting switches at point "M" and testing with a voltmeter connected to the circuit through a potential transformer for zero voltage; that is, the voltage across the other two open switches. For instance, if J and D were connected through the switch blade and the connections were correct, the voltages K-E and L-F would be approximately zero depending on the relations of the voltages J-K to D-E, J-L to D-F and K-L to E-F.

A potential transformer having a voltage rating of double the phase voltage, namely, 8 kv., should be used or two 4-kv. potential transformers connected in series on the high voltage side and in multiple on the low voltage side. The need of a higher voltage potential transformer is necessary for the following reason:

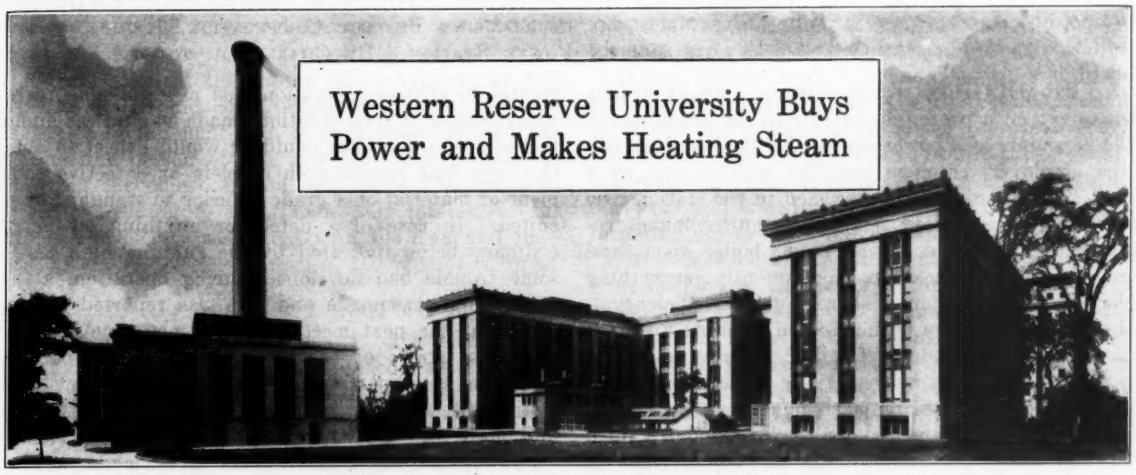
Assume that point V, Fig. 7, was connected for test to point 7, Fig. 3. Figure 9 gives this condition. It will be noted that the voltage between the open points 9 and n is equal to double the normal phase voltage, while that between 11 and p is normal. Other conditions would give different results but the case taken illustrates the point in question. A lamp bank could, of course, be used in place of a voltmeter.

Rural Electrification

An editorial in The Engineer of Nov. 26, 1926, points out that "cheap distribution is unquestionably the keynote to successful rural electrification." "Possibly, however, one of the main reasons why the electrification of continental rural districts has proved successful is that every effort has been made to simplify and cheapen distribution."

For instance, the Royal Board of Sweden has divided Central Sweden into about 400 small local distribution districts, each with an average area of about 20 sq. mi. A transformer station is located in the central part of each district from which energy is sold at wholesale rates not only to large power consumers, but also to local organizations which control their own network, supply transformers and retail rates. Generally these organizations are co-operative, each shareholder being charged for costs of construction, upkeep and management, etc. A fair density of population is required besides a fair standard of prosperity and a popular appreciation of the advantages of electricity in daily life to make rural electrification a success.

Some workmen who couldn't see the need of goggles can't see anything now, observes Walter G. King of the National Safety Council.



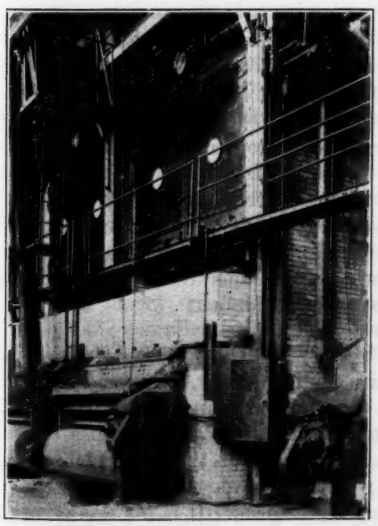
Western Reserve University Buys Power and Makes Heating Steam

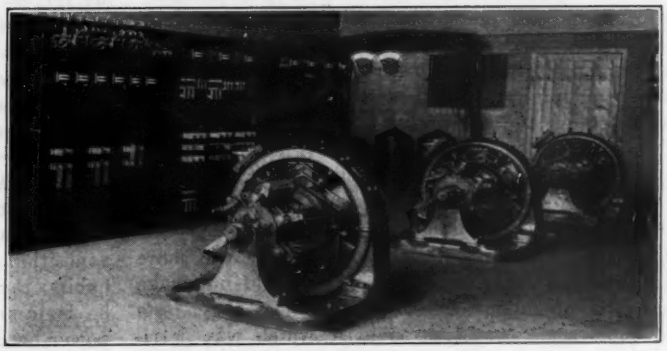
SUPPLYING STEAM for heating and process work in college buildings and maternity hospital, the power plant of Western Reserve University, Cleveland, Ohio, possesses some interesting features. Alternating current at 11,000 v. for lighting, motors and laboratories is brought by a line running direct from the central station; it is stepped down, converted into 6-phase by the transformers and again converted into 230/115-v. d.c. by three 350-kv.a. synchronous converters and distributed by an Edison 3-wire system. Two 60-t. ammonia compressors, driven by direct-connected, single-cylinder, poppet-valve uniflow engines, supply refrigeration for laboratories and hospital. Double pipe condensers are used in conjunction with these, condensing water being cooled by a spray tower on the roof.

Steam is generated at 150 lb. pressure by four 515-hp. water tube boilers, fired by motor-driven traveling grate stokers. All high pressure piping joints are welded. Coal is handled to the overhead bunker by conveyors, the motors of which are interlocked, and is measured by a weigh larry. Ash is handled by the same conveyor. Two boilers operate on natural draft, the other two having a forced draft fan. Steam for heating is passed through reducing valves.

Water is treated in a zeolite water softener of 6,000 lb. an hour capacity, heated in a deaerating heater which also supplies hot water to the building and is pumped to boilers by simplex steam pumps. Vacuum pumps are installed on the heating system and compressed air for various purposes is supplied by two steam-driven air compressors.

Charles E. Walsh is chief engineer of Western Reserve University and F. H. Penniman is chief electrician.





Personnel Meetings Boost Plant Efficiency

Such Gatherings Are Found Necessary in Securing Perfect Co-operation, High Efficiency and Safety in the Modern Power Station. By Charles A. Adams*

AS THE HEADING would indicate, I am an ardent booster and a profound believer in the organization of the personnel of a power station for the best interests of the employer, employe and the organization as a whole. The organization of the men in the station who are so closely associated with one another makes co-operation between the engine room, boiler room and operating division possible, consequently everything works in perfect harmony and with greater efficiency.

I shall endeavor, by taking for an example a station with which I am thoroughly familiar, to prove my assertion and to show that above all else the human factor, the personnel, is the predominating factor in the station and that they are benefited by the knowledge gained both collectively and individually and their value to the organization in general is thereby increased.

The station to which I have reference was the pioneer in this field of endeavor for the particular division of power stations of which it was a unit and the meetings were inaugurated under my personal supervision, the results of which I am justly proud. The first of these meetings was held with 20 members of the personnel present and at this initiatory meeting the purposes of the meetings were disclosed, and the benefits to be derived from the study of common problems and through co-operation of the personnel set forth.

Fundamental principles of the organization of the personnel is co-operation between the departments and individuals of the plant and the education of the personnel in modern engineering and power plant practice. Just how well it serves the purpose you may judge for yourself.

Knowledge of Plant Essential to Personnel

To begin with the steam generating department was taken for study and tests run, compiling all data into simple articles or essays showing conditions, results and improvements; these articles were then presented before the personnel for their study and discussion.

These articles included station efficiency, boiler and furnace efficiency, furnace construction and maintenance, boiler designs and maintenance, superheaters, feed water regulation, combustion, draft, fuel, feed water systems, operation of boilers, variations of load causing variations in thermal and combined efficiency, the relation between steam flow, air flow and CO_2 and numerous other points of interest in the operation of the steam generating department. These tests and articles were made to show the relation between the different factors that go to make up an efficient department and the articles were prepared to enlighten every member of the personnel on the operation and equipment.

The meaning of thermal efficiency, combined efficiency, average rating of boilers, equivalent evaporation, etc., was explained in detail and these factors pointed out in the tests under discussion.

It is to be understood, of course, that the mere reading and discussion of these things would not make a more efficient boiler room but as often as these tests would show some condition to exist which was detrimental to efficient operation this objectionable feature was removed or compensations made as much as humanly possible, for no one could or would expect to obtain the very best results with obsolete or defective equipment or material of a grade inferior to standard or unsuited. In case of a defect or anything out of the ordinary being indicated by the running of a test, or some trouble had developed during operation, a thorough study was made and this was reported and discussed at the next meeting of the personnel. Due to this close study of the steam generating department alone and the repairing or renewing of worn or obsolete equipment, a saving of great proportions was effected and most especially in the coal consumption.

Accurate charts and curves were made up from the readings taken during the tests and the regular operation to show the relation between the steam flow, air flow and CO_2 and it was proven to the entire satisfaction of the personnel that there was a definite relation between these factors and that a variation of one caused a variation of the other factors. From these charts it was also shown that the CO_2 was directly affected by the use of soot blowers at proper intervals and that cleaning the tubes of soot raised the percentage.

Through these simple and apparently negligible tests and operations the various small details were attended to in proper order and little by little the thing began to take definite form until these molecules of study and work have finally crystallized into a beautiful, efficient and economical steam generating station.

The electrical department, of course, is one place where little can be done, especially in raising the efficiency of the apparatus, due to the fact that the electric generator, being comparatively simple even in its most complex forms, is a source of exceedingly little loss—thanks to the research and study, and the constant improvement of this equipment by the manufacturer who now has it as near perfection as it is possible for the human mind to conceive. It is possible, however, to increase the efficiency and accuracy of the electrical department or operating division by increasing the efficiency and broadening the knowledge of the personnel of this department which is the predominating factor.

Allow me to diverge from my line of thought long enough to say that one of the greatest problems confronting the foreman in the power field today is the education of the workmen to their responsibility, duty and a thorough acquaintance with and understanding of the apparatus which they operate or with which they are thrown into constant contact.

Chief Engineer Should Select and Train His Men

As a rule, the chief engineer, being more or less in constant touch with the personnel of his station, is in a position to know better than anybody else the traits, habits, thoughts and deeds of the personnel, therefore he is familiar with the psychic qualities of the ideal power house man, so to speak. It is for this reason that the chief engineer should be given the privilege of select-

*Chief Engineer, Columbus Electric & Power Co., Columbus, Ga.

ing and educating the personnel of his station and make such changes in the position or occupation of the individuals as would be most beneficial for both the employer and employe.

An education in the theory and operation, as well as in the design and construction of the necessary apparatus and equipment in a modern power station can be given the personnel and it is with this purpose in mind that the chief can and will select his personnel for their aptitude to learn and their interest in the work; being closely associated with his men and their work, he can easily tell his man or the type of the man.

Stress Laid on Safety and First Aid

To get back to the meetings, it is a part of the regular routine of the meetings to teach, talk and think safety and first aid to the injured, and at every meeting some instruction or article is given in the interest of safety. Hazards in and about the plant were discussed and remedies suggested, with progress in this line reported, and in this way the plant has been made as safe as possible for the operator, and safeguards the equipment as well. Safety signs have been designed and installed to meet various requirements and safety appliances used on the equipment where practical or necessary. This not only reduces accidents and loss of time, but is a step forward in preventing damage to equipment or interruptions to service which might be caused by these accidents if no steps were taken to prevent them.

These meetings not only serve to increase the efficiency of the station as a whole, but are of great help in the advancement of the employes, for as the meetings were held and various subjects discussed, at some time or other a member of the personnel would show especial interest in a department of the plant with which he is not connected and possibly have talent for this line. He is then given a chance to prove his usefulness in this department and will almost invariably result in advancement of himself. All this, of course, is of value to the organization for the more experience or useful practice a man gets, the more his worth to the company is increased.

Preparation of Articles Is Helpful

To create an interest in these meetings it is necessary to give the personnel something of particular interest at each meeting and create that feeling of accomplishment and good will that will make them want to work together for the good of the meetings and their work. I know of nothing that accomplishes this so well as the preparation of articles on the theory, design, construction and operation of some machine or piece of apparatus in the station or in some other station that generates steam or power or both. Let me stop here to explain that theory, contrary to general opinion, does not mean some complicated mathematical process or the propounding of some long windy law of physics but, on the other hand, theory, in its original sense, means "useful in practice."

That was the idea in mind when these articles were begun and, to make it worth while and beneficial, the articles were always prepared each time by different members of the personnel of different departments. This, aside from providing instruction to the personnel, gave the person preparing the article a wider view and better understanding of the apparatus in question as extensive research and diligent study were necessary in most cases to make the article one of interest and importance.

These articles were wide and varied and included such subjects as superheaters, furnace walls, their construction and maintenance, stokers, protective relays, steam turbines, a.c. generators, water tube boilers, jet condensers, system operating, theory and design of alternators and transformers, first aid, power factors, alternating current and its characteristics, etc.

In each and every case these articles served to inform some member of the personnel upon some subject with which he was not very familiar and in some cases things which he had not even dreamed of.

These things, assisted by the regular meetings, have served to bind the personnel closer together in the operation of the station and to give them an understanding of the problems confronting the other departments. and make a man realize that in times of trouble on the system his boots are not the only ones that are getting wet and that the other departments are getting their share of the trouble also. In this way the departments are caused to work in harmony and for the greatest efficiency of the station from the coal pile to the a.c. bus.

As previously mentioned in this article there are numerous reasons why I should be proud of the personnel which resulted from these meetings and the results obtained both directly and indirectly from them, and I have endeavored to explain some of the most important accomplishments wrought by them and just why I am firm in my belief that personnel meetings are a necessity for perfect co-operation in the modern power station for the good of the employer, employe and the organization in general.

Report for 1926 of the National Association of Railroad and Utilities Commissions comments on government ownership as follows:

"Even if there were no other reason for private operation of electric utilities, this country could not afford to impose the stagnation of state operation on the utilities which have already enabled this country to outdistance the world in electric development.

"During 1925, 269 municipalities which operated their own electric plants abandoned government operation and resorted to privately operated plants for their electric power, because of inherent defects of government operation. . . . Managers were so handicapped by the inevitable consequences of political control that they were unable to provide the cheap and efficient service which neighboring private plants were able to supply.

"Actual records show that there are now more than 1500 municipal plants in the United States and that, out of this number, not more than 1 per cent are operating at a profit." The report also states that a total of 1129 government-operated plants have been abandoned in favor of private operation.

An Indiana farmer, who had his household and farmstead equipped for the efficient use of electricity, has this past year been able to handle 40 additional crop acres without any added expense for help, due to time which was saved in the house and the dairy barn.

Using Excess Flow to Increase Head on Turbines

SEVERAL DEVICES FOR INCREASING HEAD ON HYDRAULIC TURBINES BY USING EXCESS WATER IN HIGH FLOW PERIODS HAVE PROVED ECONOMICAL AND CONVENIENT AT LARGE HYDRO PLANTS

IN A STREAM-FLOW or run-of-river hydraulic power development some means must be provided for passing surplus water during the high flow periods. If this is done in the conventional manner by discharging the water over a spillway or through sluices adjacent to the power house the head on the turbines is usually reduced by backwater in the tailrace. Several schemes have been developed for making use of the excess water to increase the head on the turbines.

The serial report of the Hydraulic Power Committee of the Engineering National Section, N. E. L. A., issued in December, 1926, summarizes the operating and economic advantages of several methods of discharging

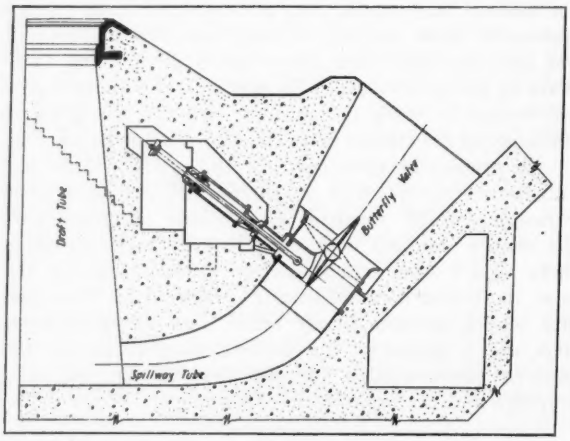


FIG. 1. TEFFT TUBE SPILLWAYS AT ALCONA DAM OF CONSUMERS POWER CO.

Two turbines under 41-ft. head have three tubes each, discharging into the draft tubes. Spillway tubes are funnel-shaped at inlet, changing to polygon and then to circular section to dissipate energy of issuing stream. Baffle down stream creates quiet pool. Control is by butterfly valve.

surplus water. Detailed descriptions are given of the Tefft Tube Spillway, the Thurlow Backwater Suppressor and the Moody Ejector Turbine.

These devices all utilize the waste energy of the fall and passage of surplus flow in excess of that required by the wheels to eliminate or offset the loss of head ordinarily produced by the rise of backwater below the dam and to recover the consequent loss of capacity and output during high-water periods. To a certain extent they may, as in the case of the Thurlow device, under moderate amounts of excess flow, actually exceed the normal low water head. Although decrease in capacity or output from high water may be ordinarily of such short duration or of so little moment, especially in systems of interconnected plants, as to warrant no additional investment in devices of this kind, some form of special sluicing or backwater suppression may be of considerable economic value where local conditions require heavy expense in providing sluicing capacity of the usual types or where there may be difficulty or expense in sluicing operations, or high water losses involved requiring considerable amounts of makeup by steam or other supplemental power.

In the case of the Tefft form of sluice, Figs. 1 and 2, which was developed for the use of the Consumers Power Co., at sites where soil bottom would make the ordinary form of sluicing difficult and expensive, a full report has been received on two representative installations, Alcona Dam and Hodenpyl Dam, from E. M. Burd of the Commonwealth Power Corp. The Hodenpyl project was completely described by Mr. Burd in the July 15, 1926 issue of Power Plant Engineering.

The statements of results in these two cases are summarized below:

(1) As to physical operating conditions, in comparison with the usual type of Tainter gate spillway, the advantages of the tube form are as follows:

(a) Considerable economy in construction.

(b) An increase in effective head by reduction of tailwater elevation brought about by the thin sheet of water rushing through beneath the draft tubes, lowering the effective tailwater elevation and producing a standing wave immediately below the power house.

(c) Ease of operation from generator room without additional man power and without the usual difficulties with ice, rubbish and the like.

(d) Elimination of a fixed spillway crest with consequent freedom to manipulate the pond to advantage.

(2) "The cost of spillway tube construction," says Mr. Burd, "will vary with each type of installation, depending upon the detail design of the power house substructure, the spilling capacity, the head at the plant, the type of gates or valves used in shutting off the water from the tubes and the operating equipment for the gates or valves themselves. To state definitely what such an installation would cost is therefore impossible. It has been found, however, that in studies of individual plant design in each case the cost of the power house with all self-contained sluices or spillway tubes is considerably lower than that of the power house and a separate spillway structure."

(3) As to physical and economic results the claims are as follows:

(a) Better construction methods and power house design, permitting safer construction on poor foundations and assisting the turning of the river during construction.

(b) Increase in effective head during high water when most desirable.

(c) Elimination of freezing, adding to the safety of the structure.

(d) Advantage of operation from the turbine room or nearby.

(e) Quiet water discharges down stream into a stilling pool, minimizing erosion.

No figures are given as to actual effect on capacity or output or cost of operation and earnings. It is stated that economy for heads below 16 ft. is questionable.

The Thurlow Backwater Suppressor type, Fig. 3, has been in operation at the Mitchell dam of the Alabama Power Co. on the Coosa River in Alabama for about 3 yr. and its operation is reported to be most

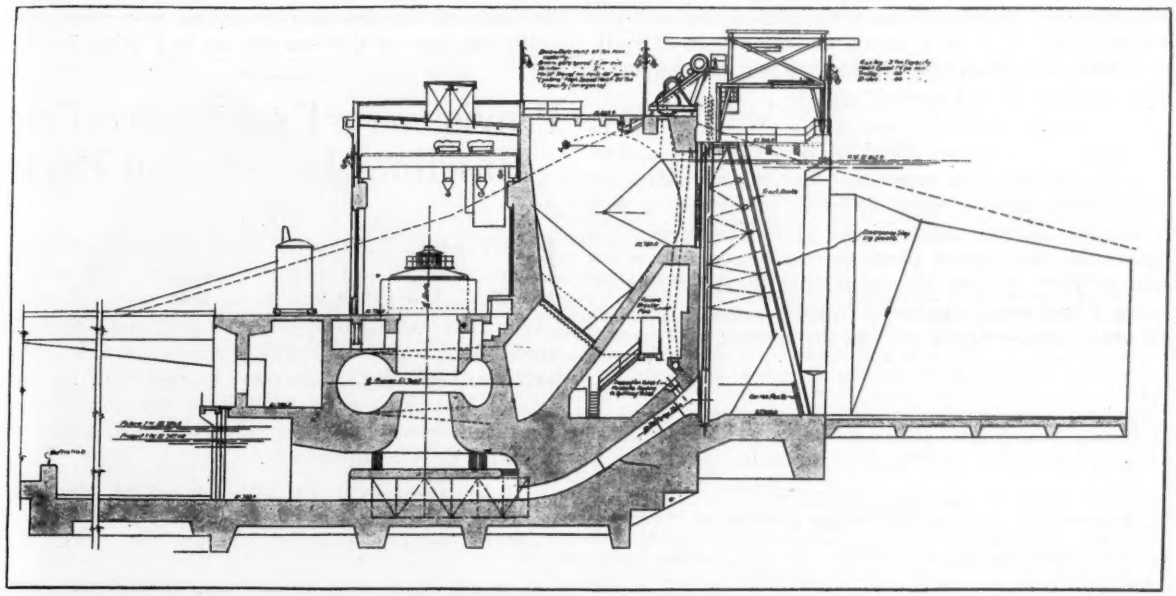


FIG. 2. HODENPYL PLANT OF CONSUMERS POWER CO. HAS THREE SPILLWAY TUBES FOR EACH UNIT

Steel-lined tubes of rectangular section run through concrete substructure discharging under hydraucone table. Control is by caterpillar gate with hoists. Downstream apron slabs and baffles to smooth out the flow are the same as at Alcona. Two 12,500-hp. units, 8888 kv.a., with double exciters operate at 65 ft. head.

satisfactory. No trouble of any nature has developed due to changes from the conventional power plant design. The normal head is 70 ft. Results reported by I. A. Winter of the Alabama Power Co. are as follows:

(1) As to physical operating conditions:

(a) "Not only can low water operating heads be maintained, but a substantial increase above low tailwater head can be realized up until tailwater has reached about 25 ft. above normal."

(b) Operation from one floor minimizes the crew.

(c) The plant and sluicing equipment are all brought under one crane.

(2) The analysis of cost of the suppressor type of plant in this case, where the whole width of channel is

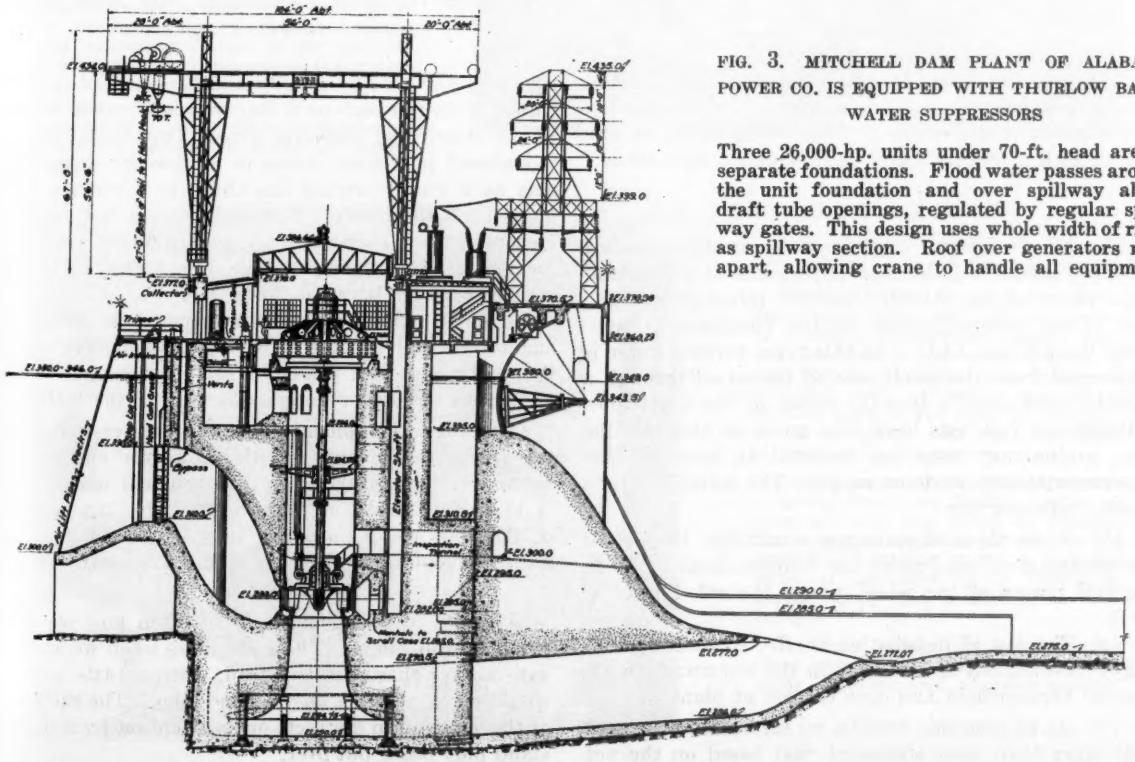


FIG. 3. MITCHELL DAM PLANT OF ALABAMA POWER CO. IS EQUIPPED WITH THURLOW BACK-WATER SUPPRESSORS

Three 26,000-hp. units under 70-ft. head are on separate foundations. Flood water passes around the unit foundation and over spillway above draft tube openings, regulated by regular spillway gates. This design uses whole width of river as spillway section. Roof over generators rolls apart, allowing crane to handle all equipment.

available for spillway, shows a material saving over the conventional plant, as a saving of over 400 ft. of spillway and excavation was effected. Each case, however, must be treated as a special problem.

(3) As to economic results, Mr. Winter states in comments on his report that "We have found in some of our studies that the suppressor has the advantage of replacing a unit in an installation of as low as five units, but in other cases it has proved to be of little value and this type of plant was not considered. Conditions vary to such an extent that the feasibility of using a backwater suppressor becomes a specific problem in every case." Quoting from the report:

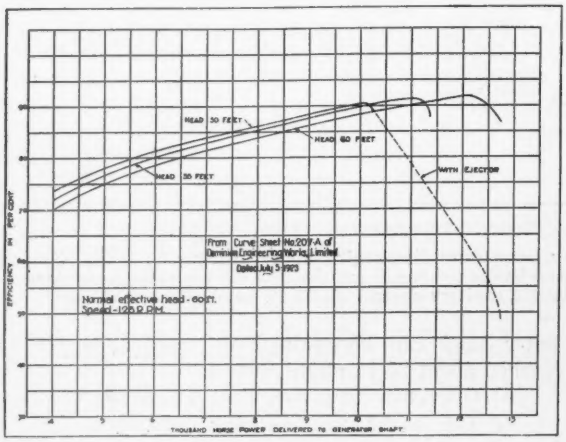

HEAD 50 FEET
HEAD 60 FEET
HEAD 50 FEET
WITH EJECTOR
From Curve Sheet No.207-A of Dominion Engineering Works, Limited Dated July 5 1923
Normal effective head - 60 Ft.
Speed - 125.0 R.P.M.
EFFICIENCY IN PER CENT
THOUSAND HORSE POWER DELIVERED TO GENERATOR SHAFT

FIG. 4. EXPECTED PERFORMANCE OF 12,000-HP. MOODY EJECTOR TURBINE OF ABITIBI ELECTRIC DEVELOPMENT CO.

Ejector consists of cylindrical gate in draft tube below runner, which allows bypassing water from casing to draft tube at high velocity, thus increasing draft head on unit and counteracting rise in tailwater.

"The power saved by the suppressor at Mitchell Dam is regarded as so much saving in steam running, and is given credit as such. This would apply to any system with a well-balanced hydro-steam combination."

Moody Ejector Turbine

The Moody Ejector Turbine was recently installed on two 12,000-hp. I. P. Morris turbines at the Island Falls plant of the Abitibi Electric Development Co., Ltd. (plant originally built by the Hollinger Consolidated Gold Mines, Ltd.). In this type, surplus water is discharged from the scroll case of the wheel through a cylinder gate directly into the throat of the draft tube. Although no full tests have been made on this installation, preliminary tests are reported to bear out the experimental tests made on models. The manufacturer's report indicates that:

(1) As to physical operating conditions, the use of the ejector maintains under the reduced head of 50 ft. the full power of the wheel under the rated head of 60 ft.

(2) The cost of installation is affected little, as only slight modification is necessary in the waterways or the general arrangement and construction of plant.

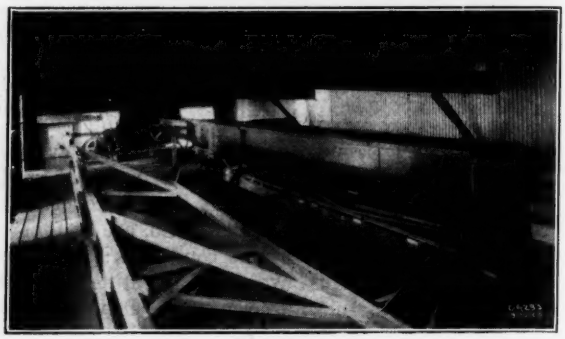
(3) As to economic results, no information is available other than their statement that based on the performance of the first two units two more units practically duplicating the first two are now being installed.

Provision for Expansion in Coal-Handling Installation Pays

By George Kunz

PROVISION FOR power plant expansion was ably met when the original coal-handling equipment of the Milwaukee Corrugating Co. was installed by the Chain Belt Co. Through this anticipation of future needs, it was possible recently to add a new 160-hp. boiler without further increase in coal-handling apparatus. The extra cost involved in this provision for the future was small compared with the necessary cost of installing new equipment.

In the plant as it was installed a year ago, coal is received in railroad cars, each car being dumped into a concrete hopper located underneath the tracks. From

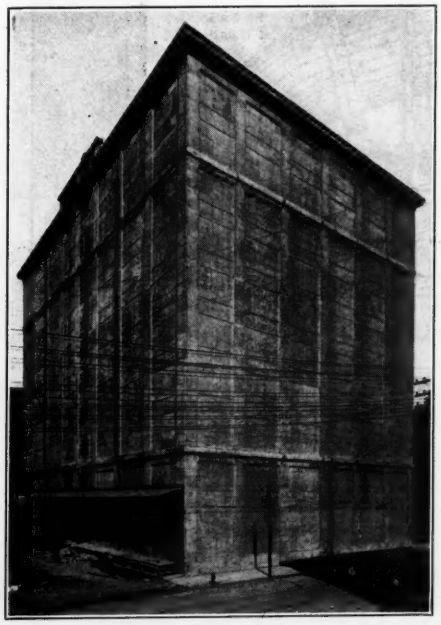


SCREW-TYPE CONVEYOR DISTRIBUTES COAL FROM BUCKET ELEVATOR TO THE VARIOUS BINS

here it is conveyed by gravity to an apron feed conveyor which feeds the coal to a Rex vertical bucket elevator of the centrifugal discharge type. This bucket elevator is enclosed in a steel casing to confine the dust, which acts as a guard around the chain and buckets which operate on the inside. The coal is then fed from the elevator into a 16-in., screw-type distributing conveyor located over the coal storage bin. This screw-type conveyor is 33 ft. 6 in. long, and will operate at a speed of 40 r.p.m., which is fast enough to handle the amount of coal necessary for the three boilers now in use. The coal then passes by gravity from the storage hopper to the stoker hoppers located at the boilers.

The entire equipment from the hopper underneath the tracks to the apron feeder conveyor elevator and screw conveyor is driven by one common motor, which is located near the elevator head. This prevents any of the units being started or stopped, except in unison, thereby avoiding overloading of any one particular unit.

IT PAYS to sit down every so often and see where you're headin' in at. There are times when we are quite sure we are chasing a live trail, when a little reflection would reveal that it's only a blind alley. The excitement of the chase often distracts one's attention from a grand stand play being put over.



Buffalo Cold Storage Co. Maintains Low Temperatures with Compound Compressors

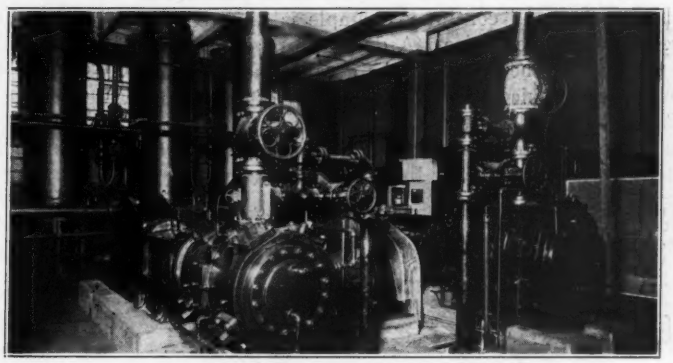
AT THE REFRIGERATING PLANT of the Buffalo Cold Storage Co., Buffalo, N. Y., an installation of two two-stage ammonia compressors has been giving good service under chief engineer C. F. Hess. This type of compressor was installed to get the benefits of its higher efficiency where extremely low temperatures must be maintained. In the storage warehouse shown at the left, which contains 3,600,000 cu. ft. of storage space, a variety of food products is stored in brine-cooled rooms, some of which require very low temperatures. For example, in the summer, butter is kept at a temperature of 0 deg. F. Beef, pork and fish are kept at 10-12 deg. F., the fish being frozen as quickly as possible.

Brine at about —20 deg. is circulated through the coils of these storage rooms by two 1500-g.p.m. centrifugal brine pumps. Brine is cooled in two shell-and-tube brine coolers, each having a capacity of 1500 g.p.m.

Power at 2200-v., a.c., is purchased, being used direct on main compressor motors and transformed to 220-110 v. for small motors and lighting. A motor-generator set provides d.c. for use on some variable speed motors; this set consists of a 90-kw., 500-v generator, belt-driven by a 150-hp. motor.

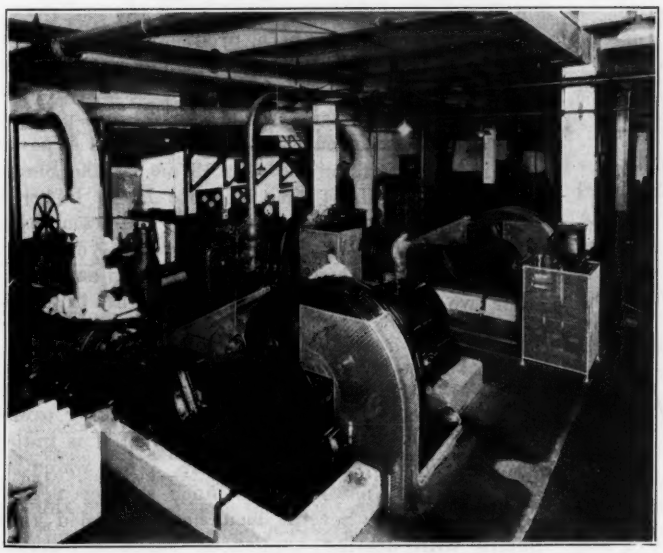
Power is brought to the plant by an underground cable direct from the central station at 2200 v. and used direct on large motors without transformation.

The plant is not manufacturing ice but is used only for refrigerating the warehouse.



At the right is shown the compressor end of one of the compound ammonia compressors. The low pressure cylinder takes suction at about atmospheric pressure, discharging at 40 lb. gage to the suction of the high pressure cylinder, with an intercooler between cylinders through which condenser water passes on the way to the condenser. In the background are the six shell-and-tube ammonia condensers, each containing 228 tubes 1½ in. by 12 ft., these condensers are equipped with separators for removing non-condensable gases. One interesting feature is the method of using the first condenser of the group in service as an oil separator.

A full complement of flow meters, thermometers and other instruments provides a continuous record of operation.



Two compound ammonia compressors, as shown at the left, are installed, one a 300-t. machine direct-connected to a 600-hp., 2200-v. synchronous motor, the other a 500-t. unit direct-connected to a 1000-hp. synchronous motor. Each machine runs at 167 r.p.m., and has its own belt-driven exciter. One machine is provided with automatic push-button starting control; the other is controlled by oil switches. Full relay protection is provided on the motors.

Cooling water can be obtained through a special line from Buffalo harbor or from two 6-in. city mains, its temperature going as high as 80 deg. in hot weather. A cooling tower is used and water is circulated by a 1500-g.p.m. duplex pump and a 1200-g.p.m. centrifugal.

Ammonia fittings are of brass and other piping is wrought iron. Van Stone joints are used wherever possible.

Fuel Oil Viscosity Regulated Automatically

AUTOMATIC VISCOSITY REGULATORS, MECHANICAL ATOMIZERS AND COMBINATION BURNERS ARE AIDS IN FUEL CONSERVATION. BY ERNEST H. PEABODY*

BY FAR the greatest advance in oil burning made in recent years is the application of wide range mechanical atomizers to the production of steam. This atomizer or pressure burner dispenses entirely with the atomizing medium, such as steam or air and sprays the liquid by centrifugal force. Heating of the oil in order to reduce the viscosity to the desired degree is a matter of importance in all such installations.

Heretofore it has been necessary to make a viscosity test of the oil to determine the proper temperature to which it should be heated. The temperatures maintained in operation were usually by hand regulation. If the oil changes in character for any reason the temperature is likely to change also, and these conditions change without the operator being aware of it. The whole matter has been simplified by the development of an automatic viscosity regulator, a cross-section of which is shown in Fig. 1.

After the oil has been raised in temperature in the heater and, while it is being pumped under pressure to the burner, a small continuous sample is diverted and passed through the device. A drop in pressure occurs, and the greater the viscosity, the greater the reduction in pressure and vice versa. In the body of the instrument and exposed to these oil pressures on opposite sides is a plate or disc attached to the stem of the valve located in the steam supply lines of the heater.

*President Peabody Engineering Corp., New York, N. Y. Abstract of paper presented before American Petroleum Institute at Tulsa, Okla.

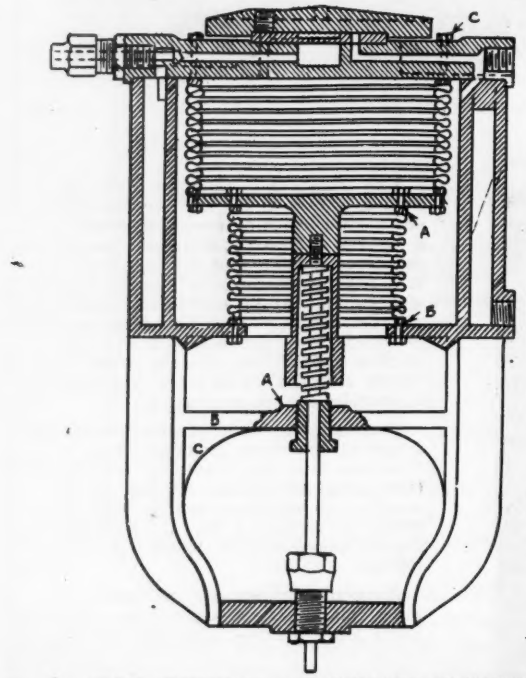


FIG. 1. CROSS SECTION OF AN AUTOMATIC VISCOSITY REGULATOR FOR FUEL OIL

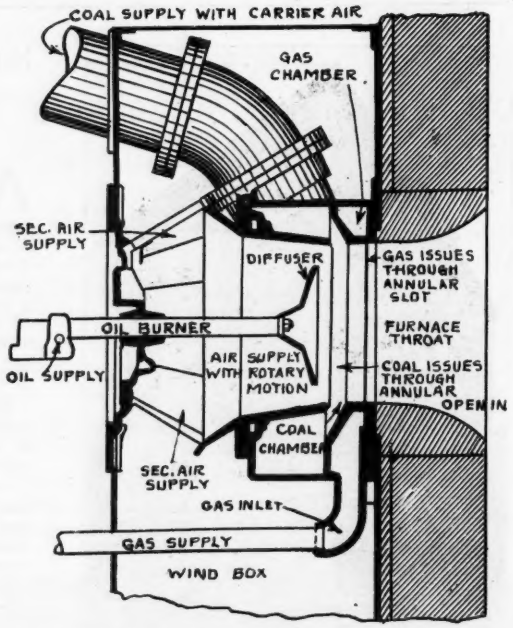


FIG. 2. TYPE OF BURNER DESIGNED TO BURN GAS, OIL OR PULVERIZED COAL

This disc is connected with two syphons of different diameters which leave the disc and attached valve stem free to move up and down, partially opening or closing the steam valve and regulating the amount of steam admitted to the heater.

Regardless of quality or quantity of oil fed to the heater the viscosity regulator controls and modifies the temperature so that the desired viscosity will always be maintained. This makes laboratory investigations of viscosity entirely unnecessary.

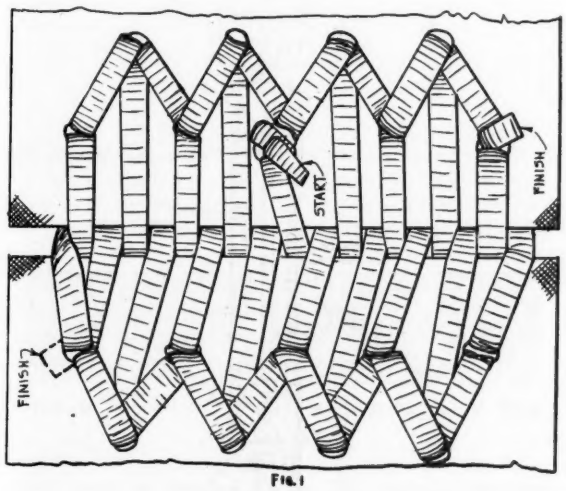
COMBINATION BURNERS HAVE WIDE APPLICATION

Mechanical burners, unlike live steam atomizers, require all the air for combustion to be admitted around the oil spray and for this purpose a so-called air register is used. In the combined type of burner, used for burning either oil or pulverized coal or oil and gas, the same air register is used for both, producing a whirling current of air to give the required turbulence. The success of the combined oil and gas burner suggested the use of modification of the same burner for oil and pulverized coal. Three experimental burners of this type have been in operation for the past 18 mo. in the Sherman Creek plant of the United Electric Lt. & Power Co., New York. Three fuel or three-fold combinations shown in cross section in Fig. 2, have not yet been put into service. It is, however, merely a combination of the other two combination burners, both highly satisfactory in service.

ELECTRICITY has made plants grow faster, helped feed fishes and fooled chickens into working overtime laying eggs. Now comes the report that it is inducing cows to give more milk in winter. When water is too cold, cows will not drink as much as they need and milk decreases. Several men have installed electric pumps with heating appliances, which automatically raise the water's temperature to the desired point.

Flexibility Increased by Hinged Lacing

HINGED BELT LACING has not been satisfactory when made with two thicknesses of lace, one above the other, because the movement of the thongs against each other causes them to wear out. Moreover, there has been considerable trouble from cutting or breaking of the lace at the points where it passes through the holes in the belting. The method described herewith avoids these troubles and produces a joint that is uniformly only one thickness of lace higher than the surface of the belt itself.



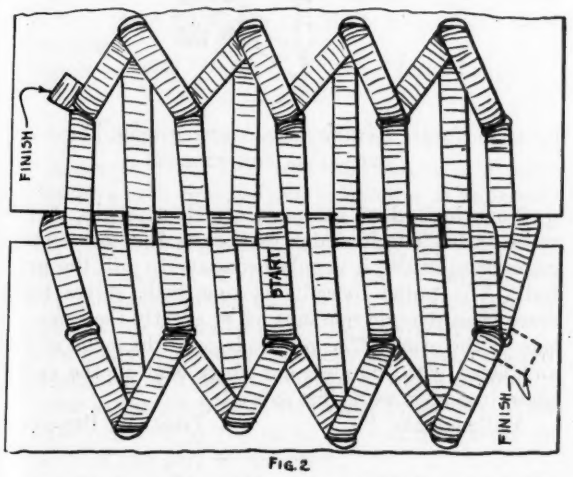


FIG. 1. ILLUSTRATING THE LACING ON THE OUTER SIDE OF THE BELT

FIG. 2. ILLUSTRATING THE LACING ON THE PULLEY SIDE OF THE BELT

Figure 1 illustrates the lacing on the outer side of the belt and shows where the lacing is started and finished. Figure 2 shows the lacing on the pulley side of the belt. The lacing is started in the middle of the belt width and the two long pieces of lace joined together by the familiar method of slotting one end of each strip, inserting each lace through the slit in the other and then pulling the laces tight. The long "stitches" or "power stitches" are the ones that do most of the pulling; the short ones anchor the ends of the long stitches and protect the ends of the long stitches but add nothing otherwise to the strength of the joint. It is this protective feature which adds life to the joint. A belt which has been operating under heavy load for several months had two of its short protective stitches worn completely in two at the points where the lace lies over a corner of the long or power stitch. This shows the protection afforded. No danger was indicated of the working stitch pulling out after the protective stitch has worn through in spots.

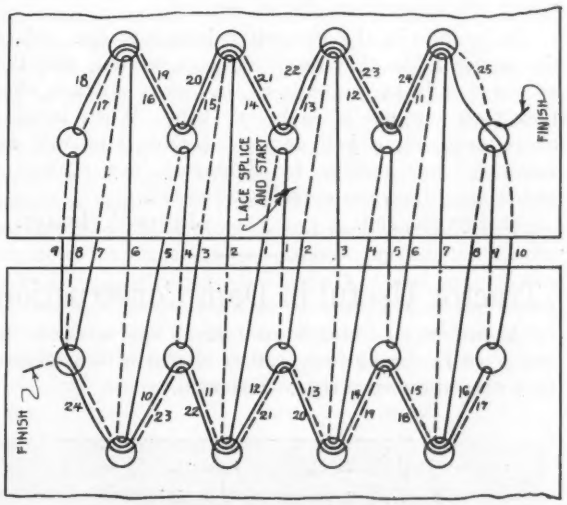


FIG. 3. ILLUSTRATING THE SEQUENCE OF LACING. ODD FIGURES REPRESENT DOWNWARD STITCHES; EVEN FIGURES, UPWARD STITCHES. FULL LINES REPRESENT STITCHES ON TOP OF BELT; DOTTED LINES, STITCHES ON THE UNDER SIDE

Following usual practice, the side of the belt on which the lacing lies the more nearly parallel to the sides of the lace, is run next to the pulley. The holes for the lacing, which are $\frac{5}{16}$ in. in diameter, are punched staggered in the ends of the belt with $1\frac{1}{8}$-in. spacing between them, one in between the edge of the belt and the first row and one in between the two rows. The

outer holes are ¾ in. from the sides of the belt. In lacing the belt, the two ends are kept $\frac{5}{16}$ in. apart. This distance may vary slightly with the belt thickness.

Before starting to lace the belt, it is best to see that sufficient length has been provided so as to avoid splicing the lacing after starting to lace. This may easily be done by adding roughly the distances between the holes in the order of sequence of lacing and adding a fair margin for safety. If necessary, the lace may be easily spliced by cutting off the lace on the side of the belt which does not run next to the pulley and at a point such that the splice will lie halfway between distant holes. The end of this lacing and the end of the lacing to be spliced to it are then slotted as done at the beginning and the added lace passed partly through the slot in the fixed lace. Then the end of the added lace passed through its own slot.

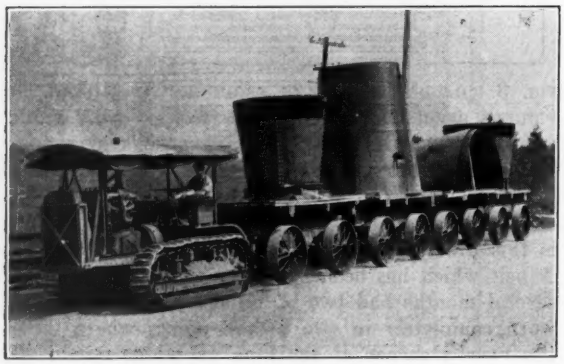
Each end of the lace is fastened at the "finish" points by cutting nicks slightly into one or both edges of the lace at the surface of the belt, giving the end a twist and then cutting it off about ½ in. from the nicks. This prevents the lace from being pulled through the hole in the belt. If properly laced, there will be no case in which the lace will be of double thickness on any power stitch on either side of the belt.

It is only in the protective lacing at the ends of the power folds, that doubling is permitted, and then as stated only at the ends of the power stitches where they pass through holes in the belt. When laced as above outlined, a belt is very flexible and will run smoothly over pulleys or tighteners, the pulleys of which bear upon the outside of the belt.

Shelbyville, Ind. JAMES F. HOBART.

Tractor Useful in Dam Construction

ACCOMPANYING PHOTOGRAPH shows how a tractor was employed in towing four trailers loaded with machinery to a dam site near Trego, Wisconsin.



CATERPILLAR TRACTOR DRAWS HEAVY LOAD

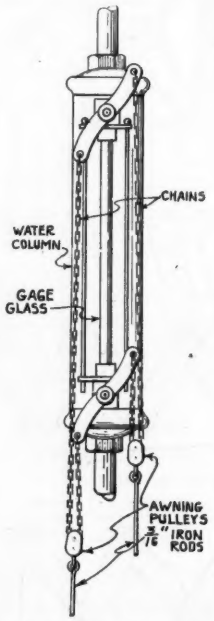
The weight of the tractor is 19,000 lb. It moves at the rate of nearly 4 mi. per hr. while drawing a load as shown. The motive power is a four-cylinder, four-cycle oil engine, fitted with 6½-in. by 8½-in. cylinders and running at 650 r.p.m. Oil is delivered under pressure to the bearings by a positive driven geared pump.

Recently a similar tractor towed a trailer loaded with a 38-t. section of a generator over 27 mi. of temporary mountain roads, up steep grades and around hairpin turns in the Sierra Nevadas.

San Francisco, Cal. C. W. GEIGER.

Operating Gage Glass Shut-Off Cocks

ANNOYED by the usual bunch of chains hanging from the shut off cocks of the gage glass on the water column of the boiler, the writer cleaned things up a little by making the arrangement shown in the illustration. Two awning pulleys that fit the chain on the cocks were obtained and the chain from one cock to the other was run through the pulley as shown. Iron rods $\frac{3}{16}$ in. diameter and long enough to be conveniently reached from the floor, were attached to each pulley.



PULLEYS AID IN MAKING OPERATION OF GAGE GLASS SHUT OFF COCKS CONVENIENT

Now, instead of having a bunch of chain that has to be sorted out in order to operate the cocks when a gage glass breaks, it is only necessary to pull the proper rod. The pulley permits closing both valves tightly even when they do not shut off at exactly the same position of the arms. The pull rods could be made of brass and fitted with handles, but rings bent in the ends of plain iron rods work just as well.

Philadelphia, Pa. THOS. W. BENSON.

Practical Uses for Weather Information Are of Interest

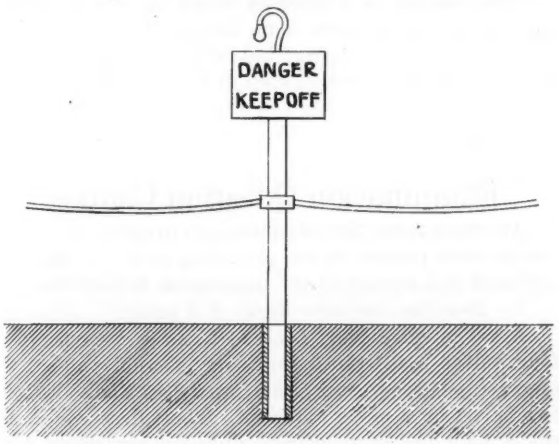
PUBLIC UTILITY companies of all kinds make use of weather information to effect economies on a large scale. In the Middle West a number of public utility companies maintain a joint committee to work in co-operation with the Weather Bureau to investigate the weather effect of a loss in weight of coal in shipping. Officials of a large railroad in Montana are asked by their headquarters in St. Paul why there has been a noticeable

falling off in coal shipments to that state as compared with previous winters. Weather records give the answer by showing that there has been a period of unusually mild weather.

Kansas City, Mo. ALLEN P. CHILD.

Post Holes in Concrete Floors

PROVISION for later use of posts in concrete floors may be easily made by setting 6-in. to 10-in. lengths of 1¼-in. or 1½-in. pipe in the concrete during construction so that they are flush with the surface as shown in the illustration. Later, if it is necessary to erect a fence, set up a lamp post, sign board or post,



POST HOLES IN CONCRETE USED TO SUPPORT SIGN POSTS AND FENCES

hydrant brace or similar device, the holes in the concrete will be found to be extremely handy. When not in use, these holes can be filled with paper or a wooden plug.

Clarkdale, Ariz. CHAS. LABBE.

Balancing Large Rotors

IT IS OFTEN found that when the rotors of a large machine have been repaired and everything is apparently in good order, severe vibration develops when the machine is brought up to speed. This, of course, is caused by unbalance of the rotors and the higher the speed of the machine the more will a small amount of unbalance of the rotors manifest itself as vibration.

Occasionally a machine that has not been repaired or disassembled will develop vibration which gradually gets worse as the machine is continued in service. This is generally caused by the parts not wearing evenly or by erosion of one part of the rotor.

The writer recalls one instance where the drain pipe from a small turbine casing was so installed as to leave about 4 in. of water in the turbine casing. This machine remained idle for about 2 mo. and, when it was started, it vibrated badly. Inspection of the rotors revealed considerable erosion of the blading at that part of the rotor which had been covered with water. This machine operated at a normal speed of 7200 r.p.m. and the erosion of those seven or eight buckets was sufficient to make it vibrate so badly that it was considered unsafe to run the turbine.

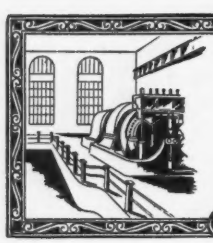
When such a condition exists it is, of course, necessary to rebalance the rotors. Small rotors that can be handled easily may be balanced on a good balancing rig if one is available. A good job of balancing, however, can be obtained with the rotors in the bearings of the machine itself. The writer has employed a method of this kind many times with good success. This method is described as follows:

First check up on the alinement. Be certain that this is absolutely correct. A few thousandths of an inch will give a great deal of trouble even with the so-called flexible couplings. Having made certain that the alinement is correct, clean about two inches of the shaft near each of the bearings down to the bright steel. Wash the bearings off with gasoline and start the machine revolving slowly. Have some whiting mixed with water at hand and apply it to the clean places on the shaft while the machine is revolving. The whiting and water should be mixed to about the consistency of paint. Now gradually bring the machine up to speed. As the speed increases, the excess whiting will be thrown off, leaving a thin film of whiting on the shaft.

Take a lead pencil with a sharp point and find a place where the hand can be rested rigidly, bringing the pencil point as close to the white place on the shaft as possible. Move the pencil towards the shaft until the point is found to touch the rotor. This is the most important part of the entire operation and it should be done very carefully. The object, of course, is to touch the heavy part of the shaft and the more lightly the shaft is touched with the pencil, the more accurately will it be possible to balance the shaft. After several marks have been made on the shaft adjacent to all of the bearings, shut down the machine and inspect the marks. If the marks go entirely around the shaft at one part of the machine, say, for instance, at the turbine, and the marks near the bearings of the fan or pump or whatever device the turbine may be driving, go only about a quarter of the way around, the fan or pump is the disturbing factor.

Contrary to common belief, the weight should not be added directly opposite the heavy side of a rotor except where the machine operates at very slow speed. At 3600 r.p.m., the weight should be placed approximately 90 deg. behind the heavy side as indicated by the pencil marks on the shaft. At lower speed, the weight should be placed further behind the marks. At about 900 or 1000 r.p.m., the weight should be placed nearly opposite the marks. After determining the proper location for the weight, try about a half pound weight. If the desired results are not obtained with this, try a lighter or heavier weight, as the case may be. If the desired results are not obtained with the first weight, do not start shifting that weight to other places on the rotor, but try a lighter or heavier weight in the same place; however, if after several attempts with different weights, the balance is still imperfect, move the weight a little one way or the other around the rotor, generally away from the marks and repeat the procedure. As a general rule, if the operation is done carefully from the start, the correct location can be determined the first time and it is only necessary to determine the proper weight to effect balance.

Sheboygan, Wis. GEORGE J. SNOWDEN.



QUESTIONS AND ANSWERS

Effect of Low Power Factor on Generators in Parallel

REFERRING TO F. O.'s question regarding the effect of low power factor on generators in parallel which appeared on page 208 of the Feb. 1 issue, the following discussion may be of interest.

In an electrical system consisting of generators operating in parallel, it is possible for one of them to drop out of step due to low leading power factor, but it is not possible for one of them to drop out due to a low lagging power factor. An analysis of the actions that take place with changes in the field strength of a generator will show why this is so.

The point at which the rotor drops out of step depends upon:

1. Generator design (synchronous impedance).
2. Load on the generator.

If the field current of the generator is reduced below its normal value for the load being carried, the power factor will approach unity. If it is reduced still further, it will become low leading, and a circulating current will be set up that is leading with respect to the main generator current. This circulating current will develop flux linkages that will pass through the field, replacing those that were lost due to the field current being reduced. If the field current is continually reduced, a point is reached where the sum of the flux linkages set up by the field and by the armature circulating currents are no longer able to hold the rotor in synchronism. The cylindrically shaped field of the modern alternator makes it impossible to link sufficient poles with the flux set up by the circulating current to compensate for the decrease in field current. As the amount of circulating current set up is inversely proportional to the synchronous impedance of the generator the particular point at which this occurs is seen to depend upon the design of the generator. The amount of torque tending to pull the rotor out of synchronism varies directly with the amount of load being carried by the generator, so this factor may cause a variation in the particular point on the power factor meter where the rotor will drop out of step.

When this happens, it is advisable to separate the machine from the system and re-synchronize, instead of attempting to "pull it in" by building up on the field.

The action that takes place when there is a low lagging power factor is practically the reverse of the action with a low leading power factor. If the field current of the generator is increased above normal, a circulating current is set up that is lagging or demagnetizing with reference to the armature current. This will tend to offset the increase in field current. It does not completely offset the increase in field current on account of the cylindrically shaped field, therefore, the total flux will be increased. As long as an increase in field strength causes an increase in the forces holding the rotor in synchronism, there is no possibility of the machine dropping out of step.

With regard to a machine dropping out at 30 per cent power factor, there is no danger if the power factor is 30 per cent lagging; but there is great danger of the rotor dropping out of step at 30 per cent leading if the generator is operating anywhere near full load.

Springdale, Pa. J. W. BATES.

Examination Question Contest

ANSWERS to the first six questions propounded in this contest were printed in the preceding issue. A third installment will appear in the issue which follows this one.

7. Describe the valve decks of a pump.

A. The valve decks consist of two decks, usually of four valves each, the lower being suction valves; the upper, discharge valves. The lower deck is divided into two halves by a metal partition. The valves are of disc shape with flat seats. They slide up and down on a stem, being held in place by a coil spring. The upper and lower seats are of one piece construction each having four parts. All valves open outward. The suction and pressure caused by the movement of the plunger acts between the decks, opening the lower valves on the suction stroke and forcing the upper valves open on the discharge stroke.

8. How would you examine a check valve while the boiler is being fed?

A. A check valve cannot be examined internally while water is being fed through it, but one can tell whether it is seating properly by the sound made at each pump stroke. By shutting the stop valve between the boiler and check valve and the valve on the inlet side, the check valve may be thoroughly examined internally.

9. What would you look out for when removing the plunger from a feed pump?

A. I would look out for a rush of hot water. There is usually no provision made for drawing the water from the pump cylinders and it remains there until the pump is opened. In removing the plunger one should remove the packing first. The section of the plunger that does not leave the barrel of the pump during any portion of its stroke will usually be coated with scale; this scale, if forced up through the packing, would ruin it. All parts should be properly marked on removal so as to insure their proper return.

10. What material is used for boiler tubes? Why?

A. Open hearth or knobbled hammered charcoal iron. Lap welded tubes can be made of either of the above but seamless drawn tubes must be made of open hearth steel because it is of more homogeneous texture.

Steel has a higher tensile strength than iron. Steel

tubes cost less than charcoal iron and are quite as good for boilers that are in constant use. For heating boilers that are idle during long periods, it is better to use charcoal iron because it resists corrosion better.

11. What is the meaning of spacing of braces?

A. The "spacing" of braces means the center to center distance between braces. Flat surfaces are braced to stiffen them. The braces are spaced so that they will carry equal loads thus distributing the pressure evenly.

12. How is the size of a safety valve determined?

A. Various formulas are used for this; one is

$$A = \frac{70W}{P} \times 11$$ for valves with 45 deg. beveled seats

and $$A = \frac{70W}{P} \times 7$$ for valves with flat seats.

where A = area of safety valve in sq. in. per sq. ft. of grate surface.

W = pounds of water evaporated per sq. ft. of grate surface per second.

P = boiler pressure in lb. absolute. 70 = constant.

11 and 8 = constants depending upon the type of seat.

Another formula is $A = 0.207W \div P$

where W = lb. water evap. per sq. ft. grate surf. per hr.

13. What are grooving and pitting? What are the causes?

A. Pitting varies in boilers from depressions of pinhead size having varying depths to general pitting in which a large area has wasted away. These pits are usually filled with a brownish pasty mass consisting chiefly of iron oxide. Pitting is caused by electro-chemical action and is aggravated by water containing salt or acid. Boiler steel may be physically uniformly the same but chemically the pitted area may have more carbon in proportion than the area immediately surrounding it. A difference of polarity has been found between iron and its oxides, especially the magnetic oxides and carbon.

With iron being electro-positive to carbon and also to its oxide, chemical action will take place in the presence of a slightly acid or salty water, at the expense of the iron. The action will be proportional to the degree of acidity of the water and to the temperature within the boiler. By introducing soda ash in sufficient amounts to make the water slightly alkaline, all electro-chemical action will disappear.

Grooving is entirely a mechanical condition. It is usually found where two plates have been stayed to one another too rigidly. This condition can be greatly aggravated by electro-chemical action, once a groove has been started by a chisel mark on the plate.

14. Are riveted or welded seams better for boilers?

A. Because poor workmanship in making a weld is hard to detect, confidence in welded boiler seams is lacking. On the other hand, riveted seams are easily estimated for efficiency of joint. Any defect in workmanship can be noted during inspection; therefore, riveted joints are at present the more popular.

15. What is wiredrawing and what is the cause?

A. Wiredrawing is reduction of steam pressure due to restricted passage through an orifice, port or pipe. This increases the velocity beyond the restriction and also causes the steam on the reduced pressure side to become superheated.

Wiredrawing is caused by steam passing through a restricted area at a high velocity. The effect of wiredrawing may sometimes be seen on valve seats and discs.

(To be continued)

Comment on Water Backing Up Into Engine

COMMENTING upon the question asked by C. L. P. on page 159 of the January 15 issue, it is impossible for an engine to draw water into its cylinder through the exhaust pipe if it were exhausting steam at every stroke. Water in the cylinder, which has entered through the exhaust pipe while the throttle valve is open, indicates that the engine must have been a large compound engine, running with little or no load on the low-pressure cylinder and very little load on the high-pressure cylinder.

A possible way would be due to faulty design of the hot well which, if too small, would act as a stoppage. Then, if the engine loses its load, the vacuum in the condenser might draw water up into the tail pipe until its seal was broken and begin to suck air. This air would act as an air lift and carry water over into the exhaust pipe and up into the low pressure cylinder.

Most engineers think the water stands in the tail pipe at a height corresponding to the vacuum maintained in the condenser but I believe there is very little vacuum in the lower part of the tail pipe while the condenser is operating under load: The vacuum exists mainly above the falling water.

Some years ago an engine was wrecked in Boston under circumstances similar to those mentioned above. It was connected, together with other engines, to a barometric condenser and all of these engines were connected to the same electric load.

At one time the load dropped so low that the other engines were taking all of it. In this case, the engine in question was probably pulled around instead of doing work, the suction created lifting water into the low pressure cylinder and wrecking it.

Medford, Mass. A. L. ALEXANDER.

Horsepower Constant

IS THE "HORSEPOWER CONSTANT," mentioned in answer 295 of your Power Plant Engineering "Questions and Answers" book, constant for all engines?

W. T. M.

A. No, this constant must be worked out individually for each engine. The horsepower constant of an engine is the power developed by one pound of mean effective pressure in the cylinder. Therefore, referring to the formula for the indicated horsepower, the constant C in any case will be: $C = LAN \div 33{,}000$

in which L = length of stroke in feet

A = area of the piston in sq. in.

N = number of working strokes per min.

The only object of establishing this constant is convenience since, when once established, the horsepower developed by a certain engine for different mean effective pressures, when no other condition has been changed, may be obtained by simply multiplying the constant by the mean effective pressure.

EDITORIAL COMMENT

Samuel Johnson and College Education

We are prone to look back upon the "good old days" forgetting that trait of human nature which obliterates unpleasant events and glorifies the pleasant ones. To admit that those days were not perfect is unforgivable, yet it is sometimes disconcerting to spend considerable time and effort on a seemingly original masterpiece of criticism or sarcasm only to find that a century or two earlier the same thoughts were expressed in almost the same words by another who could, possibly, also be accused of plagiarism.

In view of the controversy about, and criticism of, our educational systems, it is interesting to note the opinions of Dr. Samuel Johnson regarding the Universities of Scotland. In his "Journey of the Western Islands of Scotland" in 1773 he wrote:

"The students for the most part go thither boys and depart before they are men; they carry with them little fundamental knowledge and, therefore, the superstructure cannot be lofty. The grammar schools are not generally supplied, for the character of a schoolmaster, being less honorable than in England, is seldom accepted by men who are capable to adorn it, and where the school has been deficient the college can effect little."

Quite up to the modern style, so much so in fact that if one could forget the century and a half that has elapsed, the following announcement of a revised engineering curricula might be taken as a direct answer to Dr. Johnson:

"An intensive study of the problems of technical education and the changing needs of modern industry made by the faculty of Lehigh University has led to the conclusion that in the engineering curricula of the university greater emphasis than heretofore should be placed upon the fundamentals of engineering, including mathematics, physics, chemistry, and theoretical and applied mechanics, and less emphasis upon the highly specialized details of engineering practice; and that the engineer must know something of the social sciences, that is, the sciences which deal with human relations, and be familiar with the methods of business organization and administration. . . . In addition, these revisions include a substantial increase in non-technical subjects which are a part of the equipment of every well educated man and which are now recognized as essential to the proper training of engineers because of their practical applications in industrial and business life."

Not only an answer but a genuine attempt to remedy a condition that has existed in the past and which will continue to exist in the future. The faculty of Lehigh University must be given credit for assuming responsibility for training the student as he is received and not trying to shift that responsibility to the secondary schools.

They undertake the fundamental training of the student, allow him until the end of his second year to make a definite selection of the course of study to be followed and award professional engineering degrees only to graduates having the degree of Bachelor of Science. Obviously, if 150 years have been insufficient to remedy the conditions in secondary schools, they should be considered as normal conditions and the college course planned accordingly.

Is Industry's Coal Supply Assured?

With the expiration on March 31 of the Jacksonville agreement between operators and union miners, the country will probably be much interested in the attitude taken by both parties to the controversy. At this writing a joint wage conference for the competitive field is being held in Miami, Fla., and an arbitrary stand by the union officials is expected to produce an early break in the conference. There seems to be a feeling among those interested that work in the union mine fields may be suspended on March 31, although some last-minute, unforeseen development may arise to prevent this.

In view of this feeling, it is of interest to note that, although coal production has continued at a high rate during the past few months, resulting in a total of 55,000,000 t. on hand on Jan. 1, 1927, the distribution of stocks of bituminous coal in the hands of consumers on January 1, 1927, as noted by the Department of Commerce, leaves something to be desired. If the country is to go through another coal strike, industry must take steps to protect itself, regardless of the merits of the strike itself and, if the distribution of coal in the hands of consumers does not materially change between now and March 31, industry may find itself in an uncomfortable position in the event of a strike.

For example, in only three states on January 1 was there more than 90 days' supply of coal on hand and these are not considered industrial states. Illinois had less than 30 days' supply on hand, as did Pennsylvania, New York, Massachusetts, Ohio. Indiana and Michigan have more than 30 and less than 60 days' supply on hand and the southeastern states have a similar amount. A comparatively large reserve, 993,106 t., are in storage on the Great Lakes. For the rest, most of the states have less than 30 days' supply on hand and the average for the country is 41 days' supply. This condition is not serious, of course, but if it is not improved and if a strike follows, the supply will have to be maintained and the ability of the non-union mines to do this is problematical.

The wise industrialist has, of course, heard the rumble of the approaching storm and, if he has not already protected himself, it is his own fault. The fact remains that, although the present situation regarding the coal supply is not serious, it may well become so

if the parties to the present dispute become careless and refuse to consider anything outside their immediate desires. Every engineer and every industrial manager will be well repaid by a study of the data issued by the Department of Commerce covering this vital question.

Voltage Standardization of A. C. Systems

A careful study of the voltages used on power systems in this country reveals a decided lack of standardization. As pointed out in a recent paper presented before the American Institute of Electrical Engineers, there are some 18 different circuit voltages between 44,000 and 220,000. This large number of circuit voltages, together with other variables, have so complicated the situation that, in order to meet all the various requirements, one manufacturer now lists 63 different oil circuit breaker ratings between 15,000 and 220,000 v. Some of these breakers are subject to two and some to three modifications for altitude, so that something like 150 presumably standard breaker ratings are listed for the voltage range indicated. This wide variation in voltages naturally has affected transformer rating and, although transformer taps are provided, the manufacturers in their laudable effort to reduce costs have standardized a range of transformer taps that is not sufficiently flexible to meet present conditions.

A number of attempts have been made to work out a suitable system of voltage standards to correct conditions but the problem is an imposing one and so far little has been accomplished. In 1925 the transformer subcommittee of the N. E. L. A. electrical apparatus committee conducted an investigation, the results of which showed that the existing voltage standards did not allow the maintaining of voltage at the point at utilization under load conditions unless the voltage at the various generation and transformation points was maintained above normal.

It was with the view of correcting the situation that action was commenced for making a complete presentation of the entire problem to the industry as a whole in order that concerted and general action might result after all interested parties had been thoroughly informed. The vehicle selected for this purpose was a group of papers submitted at a convention of the American Institute of Electrical Engineers, these papers to be prepared by representatives of operating companies, manufacturers and consulting engineers in this country and in Europe.

The article on this subject appearing in this issue is an abstract of a paper presented in this group and discusses the subject from the viewpoint of the manufacturer. The proposed system of standards contained in this issue should be of interest to all users of electrical equipment, for it covers the whole field of voltages of a.c. apparatus and attempts to harmonize them with system voltages in such a way that all reasonable operating requirements may be met.

The importance of this entire subject may be appreciated when it is pointed out that the adoption of some such plan as the one described would help remedy a situation which has cost the public from one to two hundred million dollars.

Better Ventilation Means Better Production

Recent advances in ventilating science place industry in the unfortunate position of lagging behind research. Fundamental principles have been established but surprisingly few plants have as yet acted upon them, to the detriment be it said of production. Proper equipment has thus far taken root only in plants where air conditions affect the product, such, for example, as textiles, paint and varnish plants, bakeries and food product factories. In face of the basic truth that the condition of the air most vitally affects the production and health of the worker, comparatively little ventilation progress has been made in plants where only the human element is at stake.

We are wont to think of the atmosphere about us as being pure. More frequently than otherwise the contrary is the fact. It is not uncommon, for example, to find the air we breathe laden with dust particles as thick as 50,000 to 100,000 per cubic foot. One of the peculiar things about dust is that it becomes visible to the eye or obnoxious to the nostrils only as it approaches 700,000 to 1,000,000 particles per cubic foot,—a quantity that makes the air practically unbearable. While we are comparatively sensitive to odors, we can breathe quantities of dust which, though detrimental to health, fail to cause actual discomfort. The health departments of a score or more municipalities are at present at work on the dust problem and doubtless plant owners (as they have in many cities already) will be forced to install suitable ventilating apparatus for removing injurious dust.

Research work is constantly being carried out at the laboratories of the American Society of Heating and Ventilating Engineers to the end of bringing about improvement in heating and ventilation. That institution has already pointed the way to the many times betterment of these influential factors, but it is the exceptional factory plant owner or superintendent who fully realizes the financial benefit which comes from greater comfort and health of employes and takes steps to gain that financial benefit through the installation of air moistening and conditioning devices. Industrial plants should not wait for the civic inspector to send them notice that their working conditions are throwing into jeopardy the health of their workers. Pure air is very nearly as important as pure water, and the investment necessary for the provision of pure air is one that returns financial as well as moral benefits.

"Government is soundest when it is held strictly to its own functions. It produces the highest efficiency with the greatest economy when its field of activity is limited to those things for which government was devised. * * * You cannot make an industrial monkey-wrench of the government and then expect it to function properly as a government. You cannot make government a mentor for our minds or the monitor of our morals and expect it to serve efficiently or economically as a government."—Public Service Magazine.

This country needs, more than anything else, a true appreciation of the sound doctrines so tersely presented above, and a better realization of the true province of government.

Conference Discusses Power Applications

RAPID GROWTH OF POWER APPLICATIONS, INCREASING USE OF ELECTRICITY AND MARKED REFINEMENT OF POWER METHODS WERE CHARACTERISTIC TRENDS BROUGHT OUT AT SECOND ANNUAL MIDWEST POWER CONFERENCE HELD IN CHICAGO ON FEBRUARY 15-18, 1927

AT THE FIRST SESSION of the Conference, held at 2:30 p. m. Tuesday, Feb. 15, in the conference room of the Coliseum Annex building, Mayor Wm. E. Dever welcomed the Conference to Chicago with a brief address. He pointed out how the government of such a great city was dependent at all times on the co-operation and services of both industry and the engineering profession in the carrying on of its work. The city, he said, is greatly interested and dependent upon power development and looks to the engineer to solve many of its problems.

CHICAGO DISTRICT GROWING AS A POWER CENTER

As chairman of the Midwest Power Conference, Wm. S. Monroe, president of Sargent & Lundy, Inc., Chicago, opened the meeting with an address of welcome on "The Middle West and Power Conference." He began by calling attention to the purposes and ideals which inspired the Conference and reviewed briefly some of the causes of the remarkable growth and development of the Chicago district. He discussed in detail the vast power generating and distributing systems of the Chicago district, presenting interesting figures and charts to show the development that has taken place. The output of the power stations of the Chicago district for the past year was 4,162,300,000 kw-hr., of which 3,356,027,000 were sent out by the great plants of the Commonwealth Edison Co.

To take care of the rapidly increasing load in this district the State Line Generating Co. is to install a 200,000-kw. turbo-generator set—the largest unit ever ordered. He pointed out that the Commonwealth Edison Company at Calumet station has experimented with the burning of lower grades of Illinois coal in pulverized form, particularly with the unit system, and stated that this development has proved entirely successful. Considerable work has also been done by this company in the removal of dust from stack gases.

TRANSMISSION LINE INTERCONNECTIONS INCREASING

An interesting chart was shown of the interconnections between the power stations of the Chicago district by a number of high voltage transmission lines and underground cables. Chicago stations are all interconnected by underground cables, most of them at 13,000 v. and 20,000 v., although during the year the first 66,000 v. underground cable was put in service. Within the next few years Mr. Monroe stated Chicago will be circled by 132,000-v. transmission lines tying the stations together with a super-distributing system in the city having 66,000-v. substations.

INCREASING VALUE OF POWER TO INDUSTRY

The second address of the afternoon session was given by W. W. Freeman, president of the Union Gas & Electric Co., Cincinnati, Ohio. He first pointed out that the total capital invested in the electrical industry on January 1, 1927, was about nineteen billion dollars, of which about eight billion was invested in central stations, while the construction budgets for the central stations of the country for 1927 total almost one billion dollars. More than one and one-half billion dollars was involved in public utility financing last year—more than twice that of 1922. The kilowatt-hour sales of public utilities in 1916 were more than 21 billion kilowatt hours as against sixty-eight billion in 1926, while the number of wired homes increased from five million to fifteen million during the same period and the number of persons served from twenty million to sixty-three million.

Use of power in various industries was the general topic discussed by the various speakers at the Wednesday morning meeting which was presided over by Frank W. Martin of Sargent & Lundy. The papers on "The Use of Power in Steel Mills" by W. Sykes, Consulting Engineer, Inland Steel Co., Chicago, and "Improvement in Heat Balance and Costs in Factories of the Corn Products Refining Co." by Jos. J. Merrill are treated at some length in another part of this issue.

USE OF POWER IN PAPER INDUSTRY

In his paper on "The Use of Power in the Paper Industry," V. D. Simons, Consulting Engineer, Chicago, presented the general heat and power requirements of the paper and pulp industry and explained the methods employed for obtaining an economical balance between the two.

Mr. Simons said from pulpwood to finished paper requires about 1700 kw-hr. per t. and only about 10,000 lb. of steam, an impossible water rate for steam-electric generation. This indicates the necessity for cheap hydro-electric power for paper mills. Exhaust steam is usable, he said, for various purposes, such as cooking out ink, sizing and dirt from old paper stock and to prepare the cooking liquor and thicken the spent liquor. Other kinds of chemical pulp mills, such as make white

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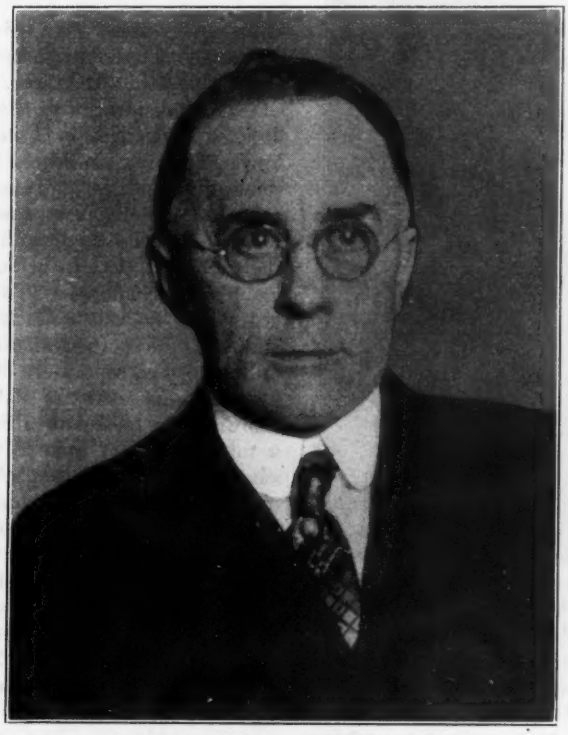

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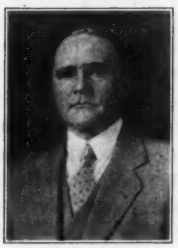

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paper from clean pulp, have but little or no use for exhaust steam.

In his discussion of Mr. Sykes' paper, G. E. Stoltz, General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, spoke of the rapid generator speed increases that have occurred recently. This speed, he said, which is three times what it was four years ago, is now 1800 r.p.m.

E. W. Lloyd, Vice-president, Commonwealth Edison Co., Chicago, regretted that steel mills did not standardize on 60 cycle. Some steel plants, he said, continue to use 25 cycle.

SAMUEL INSULL, PRESIDENT, COMMONWEALTH EDISON CO., CHICAGO, ILLINOIS

He compared the equipment of central stations and private plants by saying that the public service company buys continuously more highly efficient machines as the load on the plant increases while the private plant frequently operates apparatus long after its efficient life has passed, indicating greater possibility for lower cost of power when produced by central stations.

Power in Cement and Packing Industries

Clarence F. Hirshfeld, Chief of the Research Department, Detroit Edison Company, presided at the afternoon meeting. The papers on "A Cement Mill as a Load and Power Producer" by J. H. Lendi and on "The Production and Use of Power in the Meat Packing Industry" by C. H. Kane are abstracted at length in another part of this issue. Samuel G. Neiler, Consulting Engineer, Neiler, Rich & Co., Chicago, presented a paper on "Industrial Power Plant Developments" in which he analyzed the factors involved in industrial plant design and dwelt at length upon the utilization of waste fuel.

In discussing Mr. Lendi's paper, S. H. Mortensen of Allis-Chalmers Mfg. Co., Milwaukee, spoke of the advantages of using synchronous motors in industrial plant service since when either over or under-excited they provide a means for power factor control. They have been developed to the degree that now qualifies them for direct connection to any constant speed drive even where starting and pull-in torques in excess of load torque are required.

Waste Heat in Cement Mills May Be Sold

W. J. Williams, Chicago Sales Manager, Edge Moor Iron Company, brought out the fact that in the full utilization of waste heat in cement mills it is not only possible to produce all the power needed by the mill but that considerable power could be sold.

Co-operation with public utility companies was suggested to the end that contracts could be made by them with cement mills to absorb this excess power.

Coordination of Gas and Electric Supply

At the Thursday morning session, W. L. Abbott, Chief Operating Engineer, Commonwealth Edison Co., Chicago, presiding, Mr. Samuel Insull, Jr., in an address, "Economies of Coordinating Gas and Electric Power Supply," indicated the economic possibilities of combining the gas and electricity supply systems of a community. His treatment of this subject was purely from a financial angle and did not concern itself with the technical details, which, as he pointed out were many and formidable. To show the advantages of coordinating the gas and electric power supply, he considered the hypothetical case of a community of a half million, served separately by an electric plant of 170,000 kw. and a gas plant of 15,800,000 cu. ft. capacity. By coordinating these two utilities, Mr. Insull showed that a total saving of some $794,000 could be effected, assuming, of course, that all technical and engineering obstacles could be overcome.

In discussing this paper, W. S. Monroe of Sargent & Lundy agreed with the author of the paper in that such a coordinated system possessed numerous advantages and that if such a plan could be worked out, it should be done, but at the same time, he pointed out the technical obstacles. That there are valuable by-products to be derived from coal in the process of distillation, no one can refute, but at the present time the additional plant investment necessary to obtain these by-products more than offsets the apparent gain.

Electrical Development in the U. S.

Following the discussion of Mr. Insull's paper, Paul Clapp, Managing Director of the N. E. L. A., presented a paper in which he outlined the electrical development in the United States during the past 15 or 20 years. Dwelling briefly upon our rapid recovery from the effects of the war, he pointed out that the increase of production in this country since the war far exceeded that which would naturally be due to the 16 per cent increase in population. The amount of power available per worker has increased from two to four horsepower. This great increase in production and power available and in turn our economic wealth, was due largely to the growth and method of growth of our electric power

systems. Interconnection was a large factor in effecting the decentralization of industry which in turn would effect a stabilizing influence on agriculture.

Samuel Insull Cites Electrical Developments

At the dinner Thursday evening Samuel Insull, President of the Commonwealth Edison Co. and controller of many other public utility enterprises, was the speaker of the evening. During his 48 yr. of activity in the electrical industry Mr. Insull has been a close observer of all developments pertaining to electricity and their effects upon the living conditions, both domestic and industrial, of the peoples of the civilized world. It was this broader phase of the use and development of electricity that formed the basis of his address.

During the past 50 yr., he called to mind, the vast difference in our living conditions due to the revolutionary changes made in communication and transportation facilities, advancements in the art of illumination, increased use of refrigeration, cooling and ventilation of buildings, developments in the manufacture and use of household appliances that make the life back of the dining room more tolerable. Also in the amusement and educational activities, electricity has a place that cannot be taken by any other form of energy.

"The so-called super-power development of the last few years is not an accident. It is the economic result of the cheapening of the cost of production and of necessity in order to get the lowest possible cost of that production massed into very large quantities of energy that can be most economically produced with the largest possible prime movers.

"The power business is a pretty important business in connection with the general industrial and commercial development of the country," he said. "Very large amounts of capital are required for its prosecution, and that capital has to be invested years ahead of the demand for the product by the various industries of the country.

"I think no greater blow could be aimed at the general development of industry in these United States than anything which would attack the credit of the great power companies of the country. That is one subject our friends who sit in legislative councils need to consider well and fully before they attack an industry which bears so important a relation to the whole industrial development of the country."

Coal Location for Power Stations

H. V. Coes, vice president, Belden Mfg. Co., presided at the Friday morning session. "Location of and Coal for Central Power Stations" was discussed by Samuel A. Taylor, past president of American Institute of Mining and Metallurgical Engineers, consulting engineer, Pittsburgh. Mr. Taylor indicated that location at the mouth of coal mines was frequently inadvisable because usually the lack of a considerable amount of good water is not available at such places.

Power Distribution Dominant Factor

In the location of a power plant he also stated the first consideration must be given to the matter of distribution of the current to the consumers. The location, therefore, is largely determined by whether the distribution is to be for a large city and surrounding communities alone or whether it is intended to serve large areas. It is much more economical, he said, to build additional power lines in order to be able to locate the plants where plenty of water and coal can be obtained, even though such location may entail quite a considerable extra expense for power lines.

Recent Developments in Coal Burning

F. S. Collins, mechanical engineer, Sargent & Lundy, Inc., Chicago, presented a paper on "Recent Developments in Coal Burning." The most notable improvement, he said, has been undoubtedly the application of forced draft through the fuel bed by means of isolated wind boxes or compartments enabling the operator to control the ignition, the burning off of the volatile gases and the final reduction of incombustible refuse to the best advantage. This application increased the coal burning capacity per square foot of grate surface from a former maximum of about 30 lb. to 65 lb. without excessive ash loss.

Evaporative rates up to 350 per cent of normal rating have become ordinary practice. Due to the high furnace temperatures ranging from 2700 deg. F. to 2900 deg. F., which have been developed, and the ash fusion points of from 1900 to 2200 deg. F., the formation of slag became a formidable difficulty. Its erosive effect on the refractory and its tendency to descend in a molten condition on the grate and there solidify between the bars and the frequent rodding, raking and breaking up of the slag constitute a severe handicap to the high-duty stoker. There has been a tendency recently to swing back from the very high evaporative rates to a medium of from 225 to 275 per cent rating, with a consequent reduction of the troubles referred to.

The vertical depth of the rotary ash discharge has reduced the ash pit loss to a fraction of 1 per cent. The new system of ash distribution and the thorough mixing of air and fuel obtained have improved the combustion, while the greatly increased length of the stoker has increased the weight of coal burned per foot of furnace width to such a degree that the maximum evaporative rate attained was equivalent to 603 per cent of boiler rating.

Another feature that complicates the stoker situation is the application of preheated air. This imposes severe mechanical strains on the stoker due to unequal heating. Attempts have been made to overcome this by closing in the underpart of the drag plate in duct form and drawing the cold air through this duct to the inlet of the forced draft fan.

The development of the principle of burning coal in pulverized form and of the water cooled furnace have opened avenues of relief from the above and other difficulties.

Mr. Collins then discussed the advantages of the unit pulverizer system.

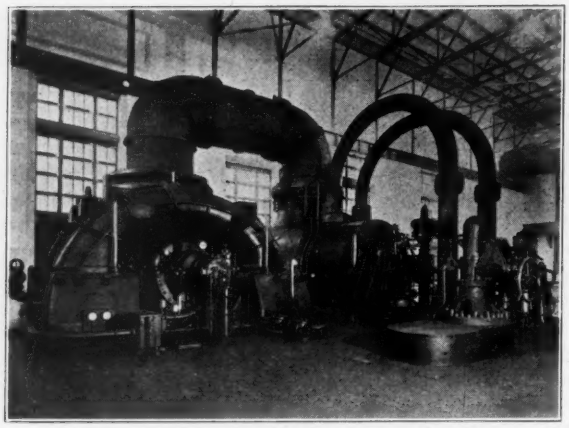
Campbell Osborn, petroleum engineer, Marland Oil Co., delivered a paper on "The Fuel Oil Situation in the Central States." Mr. Osborn said a marked change in the economic position of fuel oil in the United States has developed during the past several years, due to the changing demand for different products of the crude oil. He indicated the increased uses of fuel oil and dwelt upon the present situation in the middle west.

Speaking of the future supply he felt that the output in 1927 will exceed that of 1926, and that the peak of production may ultimately be determined by the peak demand.

New Hudson Ave. Unit to Save 50,000 t. of Coal Yearly

WITH THE FORMAL opening on February 2 of the Hudson Avenue Station of the Brooklyn Edison Co., the largest single generating unit in the world went into active service. The new power plant, which has become a landmark since its erection two years ago, was dedicated to the service of Brooklyn in the presence of more than 1000 guests, including prominent Brooklynites and business men, state officials and representatives of the electrical industry. The station, covering five acres on the East River waterfront, four and one-half acres being occupied by buildings, can at present develop 300,000 hp. with its four generating units, and has an ultimate capacity of 1,000,000 hp.

In a brief address, Matthew S. Sloan, president of The Brooklyn Edison Company, emphasized the fact



THE NEW 80,000-KW. CROSS COMPOUND UNIT AT HUDSON AVE.

that the station is the greatest concentration of electrical power in the world. President Sloan said:

"Our ambition has been to create a power plant that shall be superlative—the acme of power stations, both in respect to economy of operation and reliability. As we have gone along we have held to that ideal. This plant and the new 80,000-kw. turbo-generator which goes into operation today represent the best thought and the latest developments in the field of power generation.

"The buildings of this station occupy an area of 4½ acres. The completed station will have a capacity of 1,000,000 hp. One million horsepower on 4½ acres—there is no such concentration of power anywhere else in the world.

"The new generator we are putting into operation today has a capacity of 107,000 hp. The other three generators in this plant are new machines—they were installed in 1924 and 1925—yet this new unit is so far ahead of them that in a year it will save 50,000 t. of coal, or a matter of a quarter of a million of dollars, compared with them.

"This station uses an average of barely more than one pound of coal per kilowatt-hour of energy. The unit we are putting into operation today uses less than one pound of coal per kilowatt-hour. Throughout the state, the average use of coal for generating electricity is 2¼ lb. of coal per kw-hr. In the infancy of the industry, more than 20 lb. of coal were needed for the same amount of current."

Perhaps the most important single factor in reducing operating costs is the increase in capacity per generating unit. The new 80,000-kw. unit is a splendid example of the tendency in this direction. This is of the cross-compound type, of Westinghouse manufacture, generating current at 13,800 v., three-phase, 60-cycle, and is directly connected through auto-transformers stepping up the potential to 27,600 v. and switching onto the bus at that voltage.

The generator is provided with a closed ventilation system, using the condensate for cooling purposes. The condensate is supplemented by well water as necessary, such as at light loads or during summer conditions when the condensate is at too high a temperature for adequate cooling.

This unit, with four-stage bleeding and 375 lb. per sq. in. steam pressure at 700 deg. F., is designed to consume less than 10,900 B.t.u. per kw-hr. with loads between 55,000 and 75,000 kw.

Reduction in operating costs to result from the use of this unit, have been enhanced through a revision of the boiler plant design. The improved economies of the 375 lb. per sq. in. 700 deg. F. turbine units over the 275 lb. per sq. in. 612 deg. F. units, with only a small increase in overall first cost, will yield a good return, especially under base load operation. This pressure and temperature has leeway for a maximum safe operating temperature of 725 deg. F.

Five-stage heating of feed water is utilized in connection with this unit. The first stage heating is provided in the generator air coolers and the last four from bleeding the main unit. The boilers, condensers and economizers, together with their auxiliaries, have been selected with a view to high load operation.

It will be recalled that when plans for the Hudson Avenue Station were first published, some of its proposed features were regarded as decided innovations in prevailing engineering practice. Two years of operations have since demonstrated, however, that the features that at that time were regarded as bold were based on an accurate pre-vision of the requirements of the station as the demand for current increased.

The switching equipment of the station, particularly, was regarded as embodying a distinct element of novelty. It is interesting to note that there have been no substantial modifications in the unusual circuit breakers and associated equipment. In the connections of the main and auxiliary power apparatus, the Stott arrangement is used, each generator feeding its own section of bus. Each generator is tied with the others through reactors and a synchronizing bus. Both the main and synchronizing busses form a complete ring and permit the feeding of the two adjoining sections of the main bus from one generator, and any other section from the same generator through the synchronizing bus and reactors. The circuit breakers at each end of each main bus section are so interlocked that two generators can never be tied to the same section. In this way the interrupting duty required of the circuit breakers is reduced to a minimum, as only one generator can feed directly into a short-circuit, the current from all others being limited by a high reactance.

Work Begun at Lock 18 and Upper Tallassee

WORK OF CONVERTING the Upper Tallassee Dam into a major development has been begun by the Alabama Power Co., Birmingham, Ala., according to official announcement by President Thomas W. Martin. Upper Tallassee is familiarly known as the Montgomery Dam and is located on the Tallapoosa River 7 mi. below the Martin Dam development. Railroad construction is under way, this being the first step in the building program which will increase the generating capacity at Upper Tallassee. The height of the dam will be increased from 36 ft. to 57 ft. and its capacity from 8500 to an initial installed capacity of 50,000 hp. Provision will be made to install a third unit of 25,000 hp. later if it is found desirable to do so. When the work is well under way, 1000 men will be employed on the job.

Units to be installed will be the largest ever brought into the Southeast for a dam of such a low head, the announcement stated. A construction camp will be located between the upper and lower Tallassee dams, which latter project is also owned by the Alabama Power Co. The lower Tallassee Dam will also be converted into a major development as soon as work on the upper project is completed, the same construction force and camp being employed for both projects.

An interesting engineering feature of the reconstruction of these two dams is that the storage capacity of Lake Martin—60,000,000,000 cu. ft. of water—will increase their primary capacity at a time when the Coosa River is at its lowest stage. During the low-water period, water from Lake Martin will be released through the Martin Dam turbines and this same water will keep the turbines of the two Tallassee dams in more constant operation, performing a triple service at a time when the big generators on the Coosa River will be idle, or partially so, for lack of sufficient water.

Work has been started on the proposed $13,000,000, hydro-electric power development at Lock 18 on the Coosa River near Wetumpka, Ala., which was recently announced. The construction work followed immediately upon the order of the Federal Power Commission, Washington, granting the power company a 50-yr. license on the site and authorizing it to install locking facilities.

A great deal of the preliminary work has already been done. The railroad from Elmore, Ala., to the dam site has been completed and covers a distance of approximately 6 mi. The coffer dam construction is well under way and excavation for the spillway dam is being rushed preparatory to pouring concrete within the next two months.

It is estimated that the development will require about 3 yr. to complete and will have an initial installed capacity of 140,000 hp. with provision for installing 70,000 hp. additional at some future time and giving the development an ultimate capacity of 210,000 hp.

The dam will raise the water of the Coosa River 93 ft. and cause the reservoir thus created to reach the tail water level at Mitchell Dam 18 mi. above. It will increase the navigable length of the Coosa by that distance and with other developments will open the river to navigation for a distance of 65 mi. The dam will be 1800 ft. long and with the power house will contain approximately 450,000 cu. yd. of concrete. The area of the lock reservoir will be 4800 acres. This development, like the one at Lock 12 and Mitchell Dam, will be a run-of-river project as distinguished from a storage plant, such as the Martin Dam project which has recently been completed as described on page 284 in this issue. A high tension sub-station has already been built at Lock 18 and is connected with a power line from Mitchell Dam. Transmission lines will be rapidly extended to South and West Alabama.

Oil Power Will Be Discussed Nationally

OIL POWER WEEK will be conducted by simultaneous meetings held in different parts of the country during the week beginning April 18, 1927, by the Oil Power National Conference, an organization sponsored by The American Society of Mechanical Engineers, American Chemical Society Local Sections, National Association of Stationary Engineers, National Association of Practical Refrigerating Engineers, American Society of Naval Engineers and the American Petroleum Institute.

The purpose of Oil Power Week is to focus general attention on the production of power by the use of oil. A cash prize of one hundred dollars, accompanied by a suitable certificate to be known as The Rudolph Diesel Award, will be made at this time. This award will be made for the best contribution towards the advancement of oil engines, either in the form of a paper presented at one of the meetings which are to be held throughout the country under the auspices of the Conference, or a written discussion by anyone attending any of the meetings.

Manuscripts should be in the hands of the National Committee not later than June 1, 1927. The award will be announced by August 1. All communications regarding this competition should be addressed to the chairman of the National Committee.

Edgar J. Kates, 29 West 39th St., New York City, is chairman of the committee. Other members are R. P. Anderson, D. L. Fagnan, J. D. Jones, D. H. Killeffer, L. H. Morrison and L. H. Roller.

Walworth Co. Announces Class AA Steel Valves

WALWORTH CO., Boston, Mass., announces that a new line of Class AA steel valves is now available for 400, 600, 900 and 1350 lb. working steam pressure at 750 deg. F. The valves are trimmed with Sigmalloy No. 351. Sigmalloy is the name applied by Walworth (and registered) to valve trims and other material of special character used in Walworth valves and fittings.

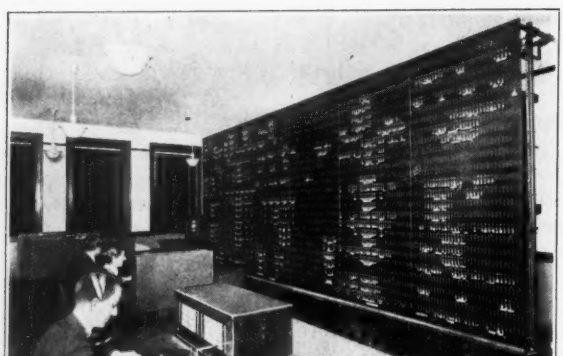
Walworth Co. recently issued an announcement to the effect that the presence of Sigmalloy indicates superior qualities of heat and corrosion resistance and strength which are not possessed by ordinary materials. Sigmalloy has been developed as the result of research work by metallurgical engineers, whose findings have made it possible for this new material to be used in

fields where unusually severe service conditions are encountered.

Two Sigmalloy valve trims, Nos. 222 and 351, have been announced to date. The former is available and recommended for steam installations at 150 and 300 lb. at temperatures up to 750 deg. F. Sigmalloy No. 351 is now available for 400, 600, 900 and 1350-lb. valves in steam and oil lines at high temperatures. The Class AA valves, ranging as high as 1000 deg. F. in temperature ratings, are designed particularly for oil refinery service. The Sigmalloy trim is being applied to the lines of Walworth Sigma steel valves made of electric cast steel under a carefully controlled foundry technique, developed on the basis of X-ray studies to determine the causes of interior defects. Subsequent experiments enabled Walworth engineers to eliminate the defects commonly found in ordinary steel castings.

New Load Control Board Installed at Newark, N. J.

AS A FURTHER means of bettering its service, the Public Service Corporation of New Jersey has installed a new electric control board on the ninth floor of the Newark Terminal Building, for centralizing its load dispatching system. This control board is the nerve center of the system which transmits and distributes the power generated in the company's 10 central stations.



VIEW IN THE DISPATCHING ROOM OF THE PUBLIC SERVICE CORPORATION

Heretofore, the load dispatching for the North and Central New Jersey areas has been divided among the Essex, Marion and Metuchen stations. From now on, operations in this field will be directed from Newark. Failures in transmission cables or wires, or any condition that causes a short circuit and therefore interferes with continuous service, will be immediately registered on the control board in the Newark headquarters. A chief load dispatcher and three assistants on the job 24 hr. a day, working in 8-hr. shifts, will detect the irregularities and by means of a private telephone system, connected with all stations and substations in the territory, will immediately direct the work necessary to correct the trouble and reinstate the service.

The control board, a view of which is shown here, consists of a large black board perforated by thousands of holes into which different colored lights have been set. Red lights indicate service normalcy, while green accompanied by white indicates trouble on the lower voltage lines. Amber indicates service normalcy and violet indicates trouble on the higher voltage lines. The board is about 24 ft. long and 12 ft. high. Each one of the 4000 lights on the board indicates the condition of switching apparatus in some part of the electric territory, so that at all times the regulation of the entire transmission and distribution system is controlled from the central load dispatching headquarters.

In this central headquarters there are also installed four totalizing meters, three showing the power load conditions at Kearny, Essex and Marion stations, and the fourth the grand total of the other three. In an adjoining room is another board, similar to the big control board, but smaller, which regulates by remote control the automatic substations in the system.

Henry W. Codding, engineer of the Production Department of the Public Service Corporation, designed the automatic indicating and supervisory control system, while Frank J. Davis, superintendent of the Telephone Department, laid out the telephone system and arranged the telephone switchboard, co-operating with Walter Mangels, system operator of the Electric and Gas Company, and engineers of the New York Telephone Company.

Second Chicago Power Show Attracts Attention

DISPELLING ANY DOUBTS regarding the permanency and wide application of high pressures and high temperatures to both central station and industrial power plant practice, the Second Chicago Power Show with almost 300 exhibitors was held in the Chicago Coliseum from February 15 to 19, 1927.

Although there were some notable changes of large equipment, including a new type single pass reversible flow condenser and four new boilers, the show was dominated by auxiliaries and appliances developed primarily to meet the changed conditions of practice brought about during recent years.

New valves for 900 lb., meters, combustion control systems, new refractory, refractory gun and wall constructions, improved stoker and pulverized coal equipment played a prominent part in the exhibit and a number of new centrifugal pump lines were announced.

Speed reducers, anti-friction bearings, gears, as well as lubrication products and methods, held the interest of industrial engineers, while many exhibits of heating and ventilating equipment broadened the show sufficiently to interest engineers in every branch of the profession.

New developments exhibited or announced, together with photographs of the exhibits, will be covered in detail in our March 15th issue, so as to give those who did not visit the show, an opportunity to read of it.

Many Big Projects in 1927 Program of P. G. & E. Co.

THE NEW YEAR found Pacific Gas & Electric Co. construction crews busy on four big hydro-electric projects. Surveyors were running their lines over Sierra slopes into the upper reaches of the Mokelumne, marking the way for the building of a road to the site of Salt Springs dam; hydraulic machinery was being set in the foundations of Melones power-house; a hundred miles to the north, in the region crossed by the old Emigrant Trail, workers were taking up the preliminary tasks of a plan for enlarging the Spaulding and Drum developments, and far up in the Cascades, near the Modoc lava beds, another group of men, heavily clad against the wintry cold, like their fellows to the south, were toiling on the facing of a new Pit River dam.

The Salt Springs development calls for a tremendous construction program—a great rock-fill dam, 220 ft. high, or more, across the Mokelumne River, a reservoir of at least 50,000 acre-feet capacity, a 25-mi. water conduit, a 44,000-hp. generating plant at Tiger Creek, and greater output for Electra power house, capacity of which is to be raised from 26,000 hp. to 44,000. The job will take 4 yr.

Work on Melones power house, which is to take water from the reservoir built on the Stanislaus by the South San Joaquin and Oakdale irrigation districts, is going ahead on a schedule that calls for completion on June 1. A 4400-ft. horseshoe tunnel, 12 ft. 3 in. high and as wide at the base, has been completed, but is yet to be concreted.

On the Spaulding-Drum developments, Drum Canal is to be enlarged, the two Spaulding power plants dismantled to make way for plants of larger capacity, a third Spaulding plant built on the rim of Lake Spaulding and the capacity of Drum power house increased from 50,000 hp. to 67,000. This work is necessary to enable the company to make full use of the additional water made available by the raising of Fordyce Dam.

In the Shasta Division, Pit 4 Dam, begun last year, is to be completed. When the concreting is finished the new reservoir will be put into service at once as an afterbay for Pit 3, permitting that plant to operate at peak at all times. Eventually Pit 4 dam will divert water for Pit 4 power plant, which is to be the next link in the company's chain of Pit River power houses.

Ohio Edison Co. Makes Progress at Mad River

THE OHIO EDISON CO. began March 15, 1926, the erection of a power plant at Springfield, Ohio. This plant is located at the confluence of Buck Creek and Mad River and will have an ultimate capacity of 100,000 kw. The first unit is to consist of one 20,000-kw. General Electric turbine generator and two Babcock and Wilcox boilers. The fuel will be supplied by Taylor underfeed stokers and the boilers are equipped with economizers and air preheaters. The steam pressure is to be 400 lb. and the temperature 725 deg. F. The surface condenser is to be made by the Elliott Co. The plant is designed to produce a kilowatt-hour for approximately 17,000 B.t.u. The Ohio Edison Co. serves Springfield and 36 other towns and villages in southwestern Ohio and the power from Mad River will be utilized in this section. The construction of the plant has progressed to a point where the steel work is completed. The roof is being put on and the building is being enclosed. It is expected that the plant will go into service August 1, 1927.

Department of Commerce Reports Stoker Sales for Two Years

FOR THE MONTH of December, 1926, the Department of Commerce has compiled statistics on sales of mechanical stokers from reports of 12 establishments, as shown in the accompanying table, which also shows comparative statistics by months from December, 1924 to December, 1926, inclusive.

TABLE SHOWING STOKERS SOLD, HORSEPOWER AND KINDS OF INSTALLATIONS

Year and Month	Establishments reporting (number)	STOKERS SOLD--		INSTALLED UNDER--			
				Fire-tube boilers		Water-tube boilers	
		Number	Horsepower	Number	Horsepower	Number	Horsepower
1926 Total	---	1,361	546,228	289	39,936	1,072	506,292
December	12	72	34,974	7	980	65	33,994
November	12	85	27,606	25	3,080	60	24,526
October	12	112	40,780	28	4,347	84	36,433
September	12	127	44,211	31	4,943	96	39,268
August	12	134	38,852	25	3,340	79	35,512
July	12	125	50,494	20	2,954	106	47,540
June	12	175	68,408	24	2,740	151	65,668
May	12	129	48,482	54	6,051	75	42,431
April	12	145	70,055	22	4,368	123	65,687
March	(1) 12	132	52,312	31	3,680	101	48,632
February	13	83	33,141	12	2,035	71	31,076
January	13	72	36,913	10	1,388	62	35,525
1925 Total	---	1,348	553,333	263	48,210	1,085	505,123
December	13	108	47,104	21	3,895	87	43,209
November	13	76	33,461	8	1,260	68	32,201
October	13	114	53,451	22	3,864	92	49,587
September	13	119	38,165	34	7,563	85	30,592
August	13	91	29,865	27	3,880	64	25,985
July	13	147	58,719	30	5,075	117	53,644
June	13	128	44,096	26	4,625	102	39,470
May	13	122	55,588	23	3,934	99	51,654
April	13	120	47,627	23	5,893	97	41,734
March	13	131	71,099	17	2,446	114	68,653
February	13	135	46,298	28	4,905	107	41,393
January	13	57	27,871	4	870	53	27,001
1924 Total	---	1,128	514,279	161	25,395	967	488,884
December	13	91	31,732	18	1,788	73	29,944

(1) One establishment discontinued the manufacture of mechanical stokers.

UNITED STATES Civil Service Commission announces an open competitive examination for the position of Assistant Mechanical Engineer, applications for which must be on file at Washington, D. C., not later than March 7, 1927. The examination is to fill a vacancy in the Naval Aircraft Factory, Navy Yard, Philadelphia, Pa., at $2400 a year, and vacancies occurring in positions requiring similar qualifications, at approximately the same rate of pay. The duties involve the testing of gas engines and engine accessories in an engine laboratory. Competitors will not be required to report for examination at any place, but will be rated on their education, training and experience. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

ANNOUNCEMENT has been made that the New England Power Co. has arranged to acquire control of the Rhode Island Public Service Co., when the latter company's plan to merge with the Narragansett Electric Lighting Co., and the United Electric Railways becomes effective.

News Notes

THE DAMPNEY CO. of America, Hyde Park, Boston, Mass., has recently opened a branch sales office in the Bourse Bldg., Philadelphia, in charge of C. J. Hunter.

INTERNATIONAL COMBUSTION ENGINEERING CORP. announces its removal, together with its American subsidiaries—Combustion Engineering Corp., Ladd Water Tube Boiler Co., and Raymond Impact Pulverizer Co., Inc.—to the International Combustion Building, Madison Ave., corners 35th to 36th Sts., New York City.

ELLIOTT CO., Jeannette, Pa., announces that its Chicago office has been moved to 1120 Conway Bldg., 111 W. Washington St., Chicago, Ill. It also announces the consolidation with this office of the Chicago office of the former Ridgway Dynamo & Engine Co., recently taken over by Elliott Co.

IN FEBRUARY announcement was made of the consolidation of The Swartwout Co., Cleveland, Ohio, and the "S-C" Regulator Mfg. Co., Fostoria, Ohio. E. K. Swartwout, president of the company bearing his name, continues as president of the merged company, while J. M. Barrett, executive head of the Fostoria company, becomes vice president. Headquarters of the new company are to be in Cleveland at the factory address, 18511 Euclid Ave. The Fostoria plant of the "S-C" Regulator Mfg. Co. is to be discontinued, the equipment being moved to the factory building of The Swartwout Co. in Orrville, Ohio.

THE SUIT THAT has been pending in the District Court of the United States at Buffalo, brought by the Worthington Pump and Machinery Corporation, against Clark Brothers Company of Olean, New York, for infringement of the Worthington patents, Reissue No. 13,991, granted October 12, 1915 and No. 1,341,145, granted May 25, 1920, on its well-known Feather valves, by the valves used in the compressors put out by Clark Brothers Company, has been decided in favor of Worthington by Judge Hazel, and a decree has been entered holding both patents valid and infringed by Clark Brothers Company's valves, and ordering an injunction and accounting against Clark Brothers Company. Under Judge Hazel's decision, Worthington Pump and Machinery Corporation has the exclusive right to the use of strip valves which bend on a uniform curve in opening, even though attached to the valve seat as in Clark Brothers Company's valve.

APPLICATIONS FOR appointment to Research Graduate Assistantships in the Engineering Experiment Station of the University of Illinois, Urbana, Ill., must be received by Milo S. Ketchum, Director of the Experiment Station, before April 1, 1927. Blanks for this purpose will be furnished by him upon request. The University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station for each of which there is an annual stipend of $600 and exemption from all fees except the matriculation and diploma fee. These Assistantships are open to graduates of approved American and foreign universities and technical schools who wish to undertake graduate study in engineering, physics or applied chemistry. Appointment is made and must be accepted for two consecutive college years of ten months each, at the expiration of which, if all requirements are met, the degree of Master of Science will be conferred. Half the time of the assistant, approximately 900 hr. for each 10-months period, is spent in work for the department to which he is assigned, the remainder being available for graduate study. Nominations are based upon the character, scholastic attainments and promise of success in the line to which the candidate proposes to devote himself, preference being given to those who have had some practical engineering experience following the completion of the undergraduate work. Appointments are made in the spring and become effective the first day of the following September. Full information may be obtained by addressing the Director.

BENJAMIN N. BROIDO, chief engineer of the industrial department of The Superheater Co., New York and Chicago, died suddenly at his home in New York on Feb. 10, 1927.

Mr. Broido was known throughout this country and abroad as a designer of steam superheaters and heat exchange apparatus. He was born in Wilna, Russia, in January, 1879, receiving his mechanical engineering degree at Frederick's Polytechnic, Gothen, Germany. From 1906 to 1912 he was connected with Aschèslebener Maschinenbau A. G., Aschersleben, Germany, and afterwards with Hannoversche Maschinenbau A. G., Hanover, Germany. He came to this country in 1914 and took a post graduate course at the City College of New York and at Columbia. At the end of 1917 he joined The Superheater Co. as designing engineer in charge of design and development of Elesco superheaters for stationary boilers.

As a member of the American Society of Mechanical Engineers he took an active part in steam power plant work, delivering many papers at various meetings of the society and contributing many articles to the various engineering magazines. He was a member of Verein Deutcher Ingenieure and the Engineer's Club of Philadelphia.

INTERNATIONAL COMBUSTION ENGINEERING CORP., New York, has officially announced the acquisition of the capital stock of the Heine Boiler Co., thus giving it large boiler shop facilities at St. Louis, Mo., and Phoenixville, Pa.

PRODUCTION OF electric power by public utility power plants in the United States for the last three months of 1926 reached a total of 6,554,588 kw-hr. in October, 6,450,302 kw-hr. in November and 6,767,333 kw-hr. in December, according to the recent report by the Department of the Interior. Average daily production of electricity for public utility plants in December established a new record with an average output of 218,300,000 kw-hr. per day, surpassing the previous record established in November by about 1½ per cent. The total output for 1926 was 73,347,000,000 kw-hr., an increase of about 11 per cent over the total output for 1925. The output by the use of water power increased 16 per cent and the output by use of fuels 9 per cent. The proportion of the total output produced by water power was 35 per cent or 1 per cent larger than in 1925. In the production of electricity in December, 1926, 3,835,569 short tons of coal were used, together with 791,956 barrels of fuel oil and 3,491,413 cu. ft. of natural gas. A special report will shortly be issued giving the annual output and fuel consumption for 1926.

SOUTHERN CALIFORNIA Edison Co., among other things, plans expenditures totaling more than $42,000,000.00 during 1927—practically a third more than the amount of the 1926 budget.

Work on the Big Creek-San Joaquin development, in the Sierras northeast of Fresno and the third 220,000-volt transmission line between the power houses on this project and Southern California, takes a large proportion of the 1927 budget.

Approximately $15,000,000 has been set aside for this work, which is more money than has ever been expended in any previous year on this particular project. A new power plant, the fifth of the Big Creek-San Joaquin series, is to be started during the year. This plant will have a capacity of 112,000 hp., and is expected to be ready for operation in the early part of 1928.

Work on the northern half of the 220,000-v. line, which is ultimately to stretch between the giant hydro plant in the high Sierras and Southern California, is to continue throughout the year; 95 miles of this line, or as far north as the Magunden substation, 6 mi. east of Bakersfield, were completed during 1926. This line is expected to be finished coincident with the completion of the fifth power house of the Big Creek-San Joaquin series.

Books and Catalogs

THE MECHANICAL WORLD YEARBOOK for 1927, published by Mechanical World, 65 King St., London, contains a number of new, as well as a number of entirely re-written sections of unusual interest to power plant engineers. A new section deals in a practical manner with belt conveyors. New material on air pumps is included, as well as a table of dimensions of vertical boilers. The section on toothed gearing has been revised and rewritten and the chapter on Condensing Plant for Steam Turbines greatly enlarged. Revisions have also been effected in the section on Structural Steel Work, while tables of cutting speeds, extra heavy steam piping, and a lengthy section dealing with rails and wheels included.

"HIGH TENSION LINE PRACTICE," by Ernest V. Pannell; first edition; 322 pages; size 6 by 9 in.; cloth; price $5.00, New York City.

In this book an attempt has been made to record the present status of that branch of electrical engineering which deals with the transmission of power at high voltages. Practice in high voltage transmission has advanced rapidly during later years and it has been difficult for the literature to keep pace.

The subject of transmission itself is one of remarkable interest. With our present lines operating successfully at voltages of 220,000, one recalls with amusement the claim made by eminent electrical engineers in 1897 that at 40,000 v. or so the electric current would escape from the wire. Harris Ryan, however, did not believe this and set out to disprove it, and he did. Voltages rose steadily to our present-day maximum of 220,000 and still there seems to be no particular difficulty in keeping the current on the wires.

Mr. Pannell in this book presents his subject in a practical manner and has collected a great amount of data on transmission line construction that should be of value to the designing engineer. His chapter on conductors is of particular interest, opening with a detailed discussion of the materials of which conductors are made and the manufacture of conductors. This is followed by a discussion on the properties of conductors and a consideration of their selection for transmission purposes.

The book is one, however, which deals essentially with the mechanical design. No attempt is made to treat of the electrical design or of electrical problems except for such brief references as are necessary to explain certain elements of the mechanical design. Special attention has been devoted to such matters as modern tendencies towards high strength conductors of composite design, heavy duty insulators, steel tower design, the construction of long crossings and construction costs. The book should be of interest to anyone having to do with the design and construction of transmission lines.

"ELECTRIC SERVICE DISTRIBUTION SYSTEMS," by Harry Barnes Gear and Paul Francis Williams; third edition; 486 pages; size 5½ by 8½; cloth; price, $5.50, New York City.

During the past 10 yr. the use of electricity for light, power and transportation has increased tremendously. As a consequence, the importance of distribution systems has increased proportionally and an up-to-date book on the subject is welcome.

In this, its third edition, this book presents a complete discussion of all phases of electric distribution. Opening with a general discussion of various systems of distribution, it treats progressively substations, voltage regulation, transformers, secondary distribution, protective apparatus, overhead construction, underground construction, distribution economics and properties of conductors.

Owing to the great increase in loads on secondary distribution systems, the chapter covering this phase of distribution has been entirely revised and brought up to date. The chapter on underground cables and cable installation also has undergone a thorough reconsideration.

Two chapters have been included for convenient reference at the close of the book, in which are compiled such tables as are likely to be needed by the distribution engineer, together with a brief outline of the laws of electric circuits. The treatment is based upon the assumption of a general knowledge of electrical theory, such as is possessed by the more advanced students of engineering and by men in practical engineering distribution work.

Much of the subject matter of the book is, however, of such a nature as to be easily grasped by practical men who have not had a full theoretical training. The subject matter has been treated entirely from the American point of view, as the book is intended for American engineers. European methods differ so much from those followed in America that the authors did not feel that their consideration would be of especial value.

AMERICAN BROWN BOVERI ELECTRIC CORP., New York City, in descriptive circular No. 100, which has just been issued, describes and illustrates attractively many types of its steam turbo-generators. Applications of these turbines to stationary plants and to marine work are

discussed, followed by several pages dealing with the design, construction and operation of American Brown Boveri turbines and generators. These turbines are normally of the combined type, the intermediate and low pressure parts being designed on the reaction principle and preceded by one or more high-pressure impulse stages; turbines of the pure reaction type are also supplied. Owing to variations in conditions, the company has developed a number of different types of these turbines. These units include machines designed to operate at pressures up to 1440 lb. per square inch and temperatures up to 840 deg. F. The bulletin contains photographs of interesting installations and photographs of the construction model of the 160,000-kw. unit designed for Hell Gate Station.

BETHLEHEM STEEL Co., Bethlehem, Pa., in a 160-page catalog, describes mine and industrial track equipment, small tools, drill steel and charcoal iron boiler tubes.

YARNALL-WARING Co., Philadelphia, Pa., in a new 4-page folder, describes the new type C Yarway seatless blowoff valve designed for pressures up to 900 lb. It differs from other valves in the Yarway line by having the lower packing set deeper in the body inlet, with a correspondingly longer plunger, thus protecting the packing from the direct flow.

HILLS-MCCANNA Co., Chicago, Ill., in a new bulletin entitled "Hills-McCanna Power Plant Equipment," discusses and illustrates in some detail its forced feed lubricators for all types of mechanical equipment. In addition, the catalog describes Hills-McCanna chemical proportioning pumps designed to measure accurately the delivery of reagents in chemical processes.

THE LATEST EDITION of the Weather Vein, published by Carrier Engineering Corp., Newark, N. J., contains an interesting account of the career of Adolph Zukor, head of the organization which has just completed the new Paramount Theater, New York City, which has been completely supplied with Carrier air-conditioning equipment.

CLIMAX ENGINEERING Co., Clinton, Ia., has issued two new bulletins describing the application of Climax Trustworthy engines to various types of equipment. Bulletin K describes power units for driving sand pumps and rock crushers, while Bulletin O covers the use of power units for portable saw mills. The bulletins contain tables showing power requirements for each industry with a list of engine models which apply to each set of conditions. Copies will be sent upon request.

EDGE MOOR IRON Co., Edge Moor, Dela., is distributing an interesting booklet containing a discussion by A. D. Flower, one of the engineers of this company, entitled "Practical Suggestions on Better Boiler Room Practice for Sugar Mills." A discussion is given of the principal losses in sugar mill power operation, together with suggestions for their elimination. Computations of these losses are of considerable value, together with several diagrams. A number of copies are available without cost to those interested and will be sent by the company upon request.

IN ITS LATEST CATALOG of Tycos Instruments for Steam Power Plants, Taylor Instrument Companies, Rochester, N. Y., describes and illustrates its various types of industrial thermometers of both standard and recording types, also recording temperature and pressure gages, recording pyrometers and temperature regulators. An interesting feature of the catalog is the index arranged to show proper selection of instruments for specific applications. Tables of dimensions and price lists for each type of instrument are given.

IN A WELL-ILLUSTRATED 40-page catalog, the Cochrane Corp., Philadelphia, Pa., presents a line of back-pressure valves distinguished by the use of a number of small disks in each valve instead of one large disk. These allow the back pressure to be changed, they can be used as atmospheric relief valves, and in similar constructions are also used in a flow valve. Another application of this multi-port idea is as a steam check valve used in bleeder connections of extraction turbines.

THE BROWN INSTRUMENT Co., Philadelphia, Pa., in an attractively illustrated 62-page catalog No. 30, describes its new electric flow meter which operates on the inductance bridge principle and also calls attention to the electric liquid level recorder, electric boiler, water level gage and the general line of Brown instruments. Copies of this new catalog will be supplied to all legitimate users on request.

GENERAL ELECTRIC Co., Schenectady, New York, in Bulletin G EA-578, describes Type D mechanical drive turbines. These are of the impulse type, pressure compounded when arranged with more than one stage and velocity compounded in each stage by using two rows of revolving buckets. They are available in capacities of 5 to 700 hp. at speeds from 1000 to 5000 r.p.m. and can be arranged for all ordinary steam conditions.

IN ITS LATEST CATALOGUE, No. 932, C. J. Tagliabue Mfg. Co., Brooklyn, N. Y., describes its new Tag-Mono-Duplex Recorder for the automatic analysis of flue gases and the like, providing visible indications of the percentages of CO_2 and CO, with permanent chart records of both. On this instrument two pointers are used—a red one and a black one. When the black pointer covers the red, there are no unburned gases passing up the chimney. When, for any reason at all, unburned gases appear in the flue gases, the red pointer immediately shows, and can be seen from a distance of 50 ft. or more. The dial is illuminated, a central alkali supply tank, designed to serve as many as eight recorders, is provided, and glass parts and rubber tubes have been eliminated except for the simple directing valve. The bulletin shows how a reading of CO_2 does not always indicate the combustion conditions correctly unless combined with the corresponding CO record.

A NEW SECTION of the Standards of the American Institute of Electrical Engineers, No. 33, is now available in final approved form. This section was adopted December 10, 1926, and is to become effective April 1, 1927. These Standards apply to the following kinds of indicating electrical instruments for direct current and alternating current: ammeters, voltmeters, wattmeters, reactive volt ampere meters, frequency meters, power factor, reactive factor, phase angle meters and synchroscopes. They are not, however, intended to apply to indicating instruments provided with arrangements for curve drawing, contact making, etc. Copies may be obtained from the American Institute of Electrical Engineers, 33 West 39th Street, New York, N. Y., at a price of 30 cents each.

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

A Trustworthy Criterion of Value

In the early days when men brought their goods to a common market to barter what they had for what they needed, they learned to trust the character of the trader rather than the appearance of his merchandise.

Today as then the character of the seller is the safest criterion of the value of the thing for sale. Glossy paint, high polish, or staunch-looking design, may cover a multitude of faults, weaknesses, cheap materials or poor construction.

The dependable test of quality in power plant equipment is: who makes it, who says it is good, who stands behind it.

It is the duty of an engineer to keep his plant operating and to keep it operating economically. His value to the field of power is proportionate to his ability to produce results, and he is able to do it only as his equipment generates and delivers efficiently.

It is vital, therefore, that he should buy only such equipment as can be depended on. He cannot afford to be content with anything short of maximum performance.

How can he be sure of getting such equipment? By testing it in advance? That is seldom possible or practical. By experience with it? That may be costly and unnecessary.

The answer is: by purchasing advertised, trade-marked equipment, because advertising is the great, modern, informative and protective agent of the buyer.

In these days of rapid and extensive business operations it is not often possible to know personally the character of the men or organizations whose products we buy. But we can know their character through their advertising provided that their advertising appears in a responsible medium, a publication which is as careful of the kind of advertising it accepts as you are of the kind of persons you admit into your home or club. Advertising in such a publication is the honest expression of a responsible seller.

In these pages you will find advertisements of firms that make every kind of machinery, equipment and supplies required for modern power plants. Their products are of tested and proved value. They are admitted here because they may be trusted to serve you.

The business day is too short, the demands upon every power plant man are too exacting, his responsibilities are too great, to investigate the claims of unknown manufacturers or to risk using an unproved product of even minor importance.

It is for your assistance, convenience and protection that the carefully prepared advertisements of reliable manufacturers are printed here.

Machinery, Equipment and Supplies Used In The Production and Transmission of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

AIR COMPRESSORS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Binks Spray Equipment Co., Chicago, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Gardner Governor Co., The, Quincy, Ill.
Ingersoll-Rand Co., New York.
Murray Iron Works Co., Burlington, Iowa.
Worthington Pump & Mach. Corp., New York.
Yeomans Bros. Co., Chicago.

AIR WASHERS.
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Forge Co., Buffalo.

ALARMS, HIGH AND LOW WATER.
Hills-McCanna Co., Chicago.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Northern Equipment Co., Erie.
Reliance Gauge Column Co., Cleveland, Ohio.
Wright-Austin Co., Detroit.

ANTI-CORROSIVE COATINGS
Dampney Co, of America, Boston.

ARCHES, BOILER COMBUSTION.
Brady Conveyors Corp., Chicago.
Burke Engineering Co., Holland, Mich.
Detrick Co., M. H., Chicago.
Girtanner Eng. Corp., N. Y.
Green Fire Brick Co., A. P., Mexico, Mo.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Hofft Co., The M. A., Indianapolis, Ind.
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Spec. Co., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

ASH BIN GATES AND DOORS.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.
Conveyors Corp. of America, Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Girtanner Eng. Corp., N. Y.

ASH HANDLING SYSTEMS.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.
Brady Conveyors Corp., Chicago.
Conveyors Corp. of America, Chicago.
Detrick Co., M. H., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Girtanner Eng. Corp., N. Y.
Link-Belt Co., Chicago, Ill.
Stearns Conveyor Co., Cleveland.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.

ASH TANKS.
Brady Conveyors Corp., Chicago.
Conveyors Corp. of America, Chicago.

BABBITT METAL.
Magnolia Metal Co., New York.

BAROMETERS.
Taylor Instrument Co's, Rochester, N. Y.

BEARING METAL.
Magnolia Metal Co., New York.

BEARINGS, ROLLER.
Timken Roller Bearing Co., The, Canton, Ohio.

BELT CONVEYORS.
Stearns Conveyor Co., Cleveland.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.

BELT DRESSING.
Dixon Crucible Co., Jos., Jersey City, N. J.
Standard Oil Co., (Indiana), Chicago, Ill.
Stephenson Mfg. Co., Albany.

BELTING.
Crandall Pkg. Co., Palmyra, N. Y.
Goodyear Tire & Rubber Co., Inc., Akron, O.
Quaker City Rubber Co., Philadelphia, Pa.
United States Rubber Co., New York, N. Y.

BELTING, SILENT CHAIN.
Link-Belt Co., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

BLOWERS, FAN AND FURNACE.
Air Preheater Corp., The, New York.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., New York.

BOILER COMPOUND FEEDERS.
Hills-McCanna Co., Chicago, Ill.

BOILER ENGINEERS.
Boiler Engrg. Co., Newark, N. J.

BOILER FEEDWATER PURIFYING APPARATUS.
Griscom-Russell Co., New York.
Paige & Jones Chem. Co., New York.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Oakmont, Pa.

BOILER FRONTS.
McLeod & Henry Co., Troy, N. Y.

BOILER MOUNTINGS.
Lunkenheimer Co., Cincinnati.

BOILER SETTING CEMENT.
Botfield Refractories Co., Philadelphia, Pa.
Green Fire Brick Co., A. P., Mexico, Mo.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Insulating Products Corp., New York, N. Y.
Obermayer Co., The S., Chicago.

To Find the Manufacturers' Advertisements of Products Listed Here, See Index Page 172

Terry Steam Turbine Co., The, Hartford, Conn.
Wing Mfg. Co., L. J., New York.

BLOWERS, FORCED DRAFT.
McClave-Brooks Co., Scranton.
Sturtevant Co., B. F., Boston.

BLOWERS, PORTABLE.
Clements Mfg. Co., Chicago, Ill.
Sturtevant Co., B. F., Boston.

BLOWERS, PRESSURE.
Carling Turbine Blower Co., Worcester, Mass.

BLOWERS, PULVERIZED COAL.
Buffalo Forge Co., Buffalo.

BLOWERS, STEAM.
Schutte & Koerting Co., Philadelphia, Pa.

BLOWERS, TUBE.
Diamond Power Spec. Corp., Detroit, Mich.
Marion Mach. Fdry. & Supply Co., Marion, Ind.
Sherwood Mfg. Co., Buffalo.
Vulcan Soot Cleaner Co., Du Bois, Pa.
Webster, Howard J., Philadelphia, Pa.

BLOWERS, TURBINE.
Carling Turbine Blower Co., Worcester, Mass.
Moore Steam Turbine Corp., Wellsville, N. Y.
Wing Mfg. Co., L. J., New York.

BOILER BAFFLES.
Boiler Engrg. Co., Newark, N. J.
Engineer Co., The, New York.
McLeod & Henry Co., Troy, N. Y.
Quigley Furnace Spec. Co., New York.

BOILER CAP CLEANERS.
Lagenda Mfg. Co., Springfield, Ohio.

BOILER COATINGS
Dampney Co. of America, Boston.

BOILER COMPOUNDS.
Botfield Refractories Co., Philadelphia, Pa.
Dearborn Chemical Co., Chicago.
Hawk-Eye Compound Co., Blue Island, Ill.
McLeod & Henry Co., Troy, N. Y.
Paige & Jones Chem. Co., New York.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Spec. Co., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

BOILER SETTINGS.
Botfield Refractories Co., Philadelphia, Pa.
Green Fire Brick Co., A. P., Mexico, Mo.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Spec. Co., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.
Webster, Howard J., Philadelphia, Pa.

BOILER TUBE CLEANERS.
General Specialty Co., Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., The Wm. B., Buffalo, N. Y.
Roto Co., The, Hartford, Conn.
Sherwood Mfg. Co., Buffalo.

BOILER TUBES.
Babcock & Wilcox Tube Co., The, Beaver Falls, Pa.
Murray Iron Works Co., Burlington, Iowa.
Scully Steel & Iron Co., Chicago.

BOILER WALL COATINGS.
Botfield Refractories Co., Philadelphia, Pa.
Insulating Products Corp., New York, N. Y.

BOILERS.
Babcock & Wilcox Co., New York.
Badenhausen Corp., Cornwells Heights, Pa.
Bigelow Co., The, New Haven.
Brownell Co., The, Dayton, O.
Casey-Hedges Co., The, Chattanooga, Tenn.
Edge Moor Iron Co., Edge Moor, Del.
Erie City Iron Wks., Erie.
Heine Boiler Co., St. Louis.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Springfield Boiler Co., Springfield, Ill.
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville, Ky.
Webster, Howard J., Philadelphia, Pa.
Wickes Boiler Co., The, Saginaw, Mich.

BOOKS AND SCHOOLS.
Audel & Co., Theo., New York.
Hays Institute, The, Chicago, Ill.
McGraw-Hill Book Co., Inc., New York, N. Y.

BREECHINGS.
Connery & Co., Inc., Philadelphia.

BRUSHES, DYNAMO & MOTOR.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, WIRE.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.

BUCKET ELEVATORS.
Brady Conveyors Corp., Chicago.
Link-Belt Co., Chicago, Ill.
Webster Mfg. Co., The, Chicago.

BUCKETS, CLAM SHELL.
Orton Crane & Shovel Co., Chicago.

BUCKETS, COAL HANDLING.
Orton Crane & Shovel Co., Chicago.

CARRIERS, PIVOTED BUCKET.
Webster Mfg. Co., The, Chicago.

CASTINGS.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Girtanner Eng. Corp., N. Y.
Hills-McCanna Co., Chicago, Ill.
Neemes Fdry., Inc., Troy, N. Y.

CEMENT, FURNACE.
Botfield Refractories Co., Philadelphia, Pa.
Green Fire Brick Co., A. P., Mexico, Mo.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Insulating Products Corp., New York, N. Y.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Lock Haven, Pa.
Quigley Furnace Spec. Co., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

CEMENT, HIGH TEMPERATURE.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Quigley Furnace Spec. Co., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

CEMENT GUNS.
Cement - Gun Co., Inc., The, Allentown, Pa.

CEMENT, IRON.
Smooth-On Mfg. Co., Jersey City, N. J.

CEMENTS, INSULATING.
Insulating Products Corp., New York, N. Y.